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THE HISTORY OF EVOLUTIONARY THOUGHT.

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SIR WILLIAM THOMSON, in his Address at Edinburgh in 1871, said that 'the real origin of the British Association' was given in the words of a letter written by David Brewster to John Phillips on February 23, 1831, a few months before the first meeting: 'The principal object of the Society would be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, and to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress.' That the time was fully ripe for the birth of the Association is made very clear by the words writtten by John Keble to a friend, referring to the D.C.L. degrees conferred, at the Oxford meeting in 1832, on David Brewster, Robert Brown, John Dalton and Michael Faraday: 'The Oxford Doctors have truckled sadly to the spirit of the times in receiving the hodge-podge of philosophers as they did'—an opinion on which Lord Salisbury commented at the Oxford meeting in 1894: 'It is amusing at this distance of time, to note the names of the hodge-podge of philosophers whose academical distinctions so sorely vexed Mr. Keble's gentle spirit.' It is not only amusing but pathetic that such words should have been used by a revered member of a University which had done splendid service for science, as has been so well shown in Dr. R. T. Gunther's volumes.[1]

Faced by the serious duty of preparing this address, I felt that the best hope of interesting you would be to choose a subject which has received special attention at our meetings. I have selected the progress of thought on Organic Evolution as it may be followed in addresses, papers, and discussions, mainly restricting myself to the series of meetings which began with the Jubilee at York in 1881, the first of many that I have had the pleasure of attending.

The British Association provides a very favourable field for the discussion of many-sided subjects such as Evolution—subjects which attract members from very different as well as from closely related Sections. Hence a wide range of varied experience is open to one who can look back over more than half a century; and I do not propose to exclude some of the humorous sayings and incidents which, from time to time, have enlivened our meetings and contributed to their success. Some of them certainly deserve to be rescued from oblivion, although to perform this pious duty I must risk the enmity of the Goddess of Folly,

[1] *Early Science in Oxford*, 1-11.

who as Erasmus tells us, proclaimed: 'I hate a man who remembers what he hears'.

The Fiftieth Anniversary at York was a memorable meeting, with Sir John Lubbock (Lord Avebury) as President, and the Chair of every Section except Economics, under Grant Duff, taken by a Past-President of the Association.

I then enjoyed to the full one of the chief benefits conferred by our Association upon its younger members—the opportunity of meeting older men, up to that time only known to them by the fame of their discoveries. Prof. O. C. Marsh had come over from Yale, his main object being to buy for his University Museum the second and more perfect fossil of the wonderful ancestral bird Archæopteryx, with teeth and a long, lizard-like tail clear evidence of Reptilian origin. The earlier example had been bought for the British Museum at a price which was said to have provided the dowry for a professor's daughter, and Marsh soon realised, as he told me, that the second was not for sale on any terms. 'We let the other go and I believe they would kill me if this were sold' was the reply given to him by the authority in Munich. He was, however, able to study the fossil, and his description and drawings of the teeth, in the Geological Section, followed the only attack on Evolution itself, as distinct from its causes, which I have ever witnessed at any of our meetings. It was the exhibition by H. G. Seeley of his reconstruction of Archæopteryx from this fossil, which aroused the fury of the palæontologist, old Dr. Thomas Wright of Cheltenham: 'Archæopteryx hasn't got a head, how can it possibly have teeth?' he growled, knowing nothing of the latest find or of the fact that a detached head and scattered teeth had been detected on the slab in which the older specimen was embedded. In spite of Prof. Newton's positive statement and the form of the teeth, drawn by Prof. Marsh at the request of the Chairman, Dr. Wright, quite unconvinced, continued muttering 'Archæopteryx is a very good bird,' its virtue in his opinion entirely uncontaminated by any taint of Reptilian affinity.

Prof. Marsh also read a paper in the Zoological Section on his own wonderful discoveries of toothed birds from the rocks of the western United States. Richard Owen, President of the Section, was in the Chair and, with the memory of old and embittered controversies in his mind, the author told me that he had felt rather anxious in bringing this communication forward. But in that friendly atmosphere there was no reason for alarm. Owen welcomed the paper warmly and in confirmation told us, in the most charming manner, of the traces of teeth found in an embryo-parrot.

The event which stands out most clearly in my memories of the Jubilee meeting is Huxley's evening lecture on 'The Rise and Progress of Palæontology'—the science which provides an essential part of the foundation on which Geographical, Geological and Biological evolutionary history has been built. The insuperable difficulty felt by the older naturalists was to believe that the land had been for the most part deposited under the sea, and to account for the presence of fossils, or as they were called, 'formed stones'. The true solution, Huxley explained, was found and published in 1669 by Nicholas Steno, a Danish Professor of Anatomy at Florence, who carefully studied certain fossils, known as 'glossopetræ,' which abounded in the Tuscan rocks and were believed to be fossil fig-leaves. Steno who was not satisfied with this interpretation, dissected a shark's head and showed that the 'glossopetræ' exactly corresponded in every particular with the teeth—'that in fact they were shark's teeth.' The emphasis with which Huxley made this statement comes back to me after the lapse of nearly sixty years. From this Steno was led to conclude that they were the teeth of shark-like fishes living in the Tuscan sea and later embedded, with other remains, in the strata which had there accumulated.

I have not noticed the fanciful suggestion of 'fossil fig-leaves' in any published version or account of Huxleys' lecture that I have seen, but he certainly told us of it and it is an interesting example of the attempts made by the naturalists of the day to explain the fossils embedded in rocks then believed to be of terrestrial origin. I cannot resist the temptation of quoting Plot's[2] more ingenious and amusing

[2] *The Natural History of Oxfordshire, being an Essay towards the Natural History of England*, by Robert Plot, D.D. Printed at the Theater in Oxford, 1677. Dedicated to the most Sacred Majesty of Charles the Second, King of Great Britain, France and Ireland, Defender of the Faith, etc. (Pp. 118–122.)

effort to account for the well-known layer of oyster-shells (*Ostrea bellovacina*) found '... at some places here in *England*, Particularly at *Cats-grove* (now Katesgrove) near Reading...; which how they should come here without a *Deluge*, seems a difficulty to most men not easily avoided.'

Plot was, however, helped 'to a *salvo*' for his own objection by remembering that Reading was 'a *Town* of very great *action* during the *Invasions* of the *Danes*, who cutting a deep trench cross between the *Kennet* and *Thames*, and inclosing themselves as it were in an *Island* held it against King *Ethelred*, and *Alfred* his Brother a considerable time; from whence in all probability, the *Saxons* having removed their *Cattle* and other provisions before the *Danes* arrival, 'tis likely they might be supplied from their *Navy* with *Oysters*, which during the time of the aboard of the *Army* on Land, might be a very suitable employment for it: Which conjecture, if allowed, there is nothing more required to make out the possibility of the bed of *Oysters* coming thither without a *Deluge* but that *Cats-grove* was the place appointed for the *Armies* repast'.

The probability of this suggestion may be inferred from the age of the 'Woolwich and Reading' beds in which the oysters are found—estimated by my friends Prof. Watts and Prof. Hawkins at about 50 to 60 million years.

Dr. Plot's explanation of fossils in general as well as of flowers was of a very different kind. To account for their existence he appealed 'to the wisdom and goodness of the *Supreme Nature*, by the *School-men* called *Naturans*, that governs and directs the *Natura naturata* here below, to beautifie the World with these varieties; which I take to be the end of such productions as well as of most *Flowers*, such as *Tulips*, *Anemones*, &c. of which we know as little use as of formed stones.'

The modest and withal amusing paragraph which follows I venture to quote in full as an example to be followed in scientific controversy:

'And thus I have given the grounds of my present *opinion*, which has not been taken up out of *humor or contradiction*, with intent only to affront other worthy Authors modest conjectures, but rather friendly to *excite them*, or any *others*, to endeavour collections of *shell-fish*, and parts of other *Animals*, that may answer such *formed stones* as are here, already or may hereafter be produced: Which whenever I find done, and the reasons alleged *solidly* answered, I shall be ready with acknowledgment to retract my *opinion*, which I am not so in love with, but for the sake of *Truth* I can cheerfully cast off without the least reluctancy.'

One chief object which, as I believe, Huxley had before him, was to bring forward a calm, clear statement of the evidence on which alone it was possible to achieve that 'reconstruction of an extinct animal from a tooth or bone,' which had made so deep an impression on the imagination. The reconstruction was in fact a simple inference based on anatomical experience such as that gained by Steno when he dissected the shark and concluded that the 'glossopetræ' were the teeth of shark-like fishes. But this reasoning—that a fossil tooth or bone on the surface of a rock, cannot by itself enable the geologist to predict that a skeleton of a certain type lies hidden beneath—seeming to diminish the glory of Cuvier's splendid work, was resented by Owen who had replied with the bitter taunt that a tooth can tell us a great deal—a donkey can kick his master but he cannot eat him. This may have been the encounter referred to by Huxley when he wrote of a friendly meeting with Owen at the Zoological Section of the Association in Leeds (1858): 'so that the people who had come in hopes of a row were (as I intended they should be) disappointed.'[3] In the same spirit, I think, Huxley was glad to speak of the 'glossopetræ' at the Jubilee meeting, where Owen was President of a Section, and calmly and simply, to reaffirm conclusions which are unassailable.

Huxley then passed on to Steno's further study of fossils and his proof of their relationship to terrestrial freshwater and marine organisms, and to his application of this evidence to the past condition of Tuscany—all discussed 'in a manner worthy of a modern geologist' and later extended by Buffon to all parts of the world then known to be fossiliferous. These conclusions, 'which

[3] *Life and Letters*, Vol. 1, p. 157.

almost constitute the framework of palæontology,' only required one addition, made towards the end of the eighteenth century by William Smith, who showed that geological strata contained characteristic fossils so that rocks of the same age could be identified in all parts of the world, while the biologist could follow the changes in the living population of the globe—a record of constant extinction and continual generation of new species. We were then led to three general conclusions: (1) the vast length of time during which life has existed on the earth—'certainly for millions of years'; (2) the continual changes which living forms have undergone during this period; (3) the successive changes in the best-known fossil groups are such as we should expect if each series 'had been produced by the gradual modification of the earliest form....' This last conclusion meant evolution which so completely accorded with recent discoveries that 'if it had not existed, the palæontologist would have had to invent it.'

I can never forget the words spoken to me after the lecture by a dear friend of my youth, the late Viriamu Jones, Principal of University College, Cardiff: 'At every sentence I felt myself bowing to Huxley and saying "you are the greatest man here; no one else could have said that as you have said it."'

As Huxley's lecture continued in a calm spirit an embittered controversy, so his thoughts on the immensity of past geological and biological time lead naturally to another controversy on the age of the earth conducted intermittently at our meetings between 1892 and 1921. It is, I think, a good example of the invaluable help which the British Association brings to discussion when there appears to be a difficulty in reconciling the conclusions reached by the followers of different sciences. Lord Kelvin's estimate of a hundred million years as the period during which the earth had been cool enough to permit the existence of life upon its surface—a period reduced by Prof. Tait to ten million—was a great difficulty to geologists and biologists who believed that an immensely longer time was required for the history of the fossiliferous rocks and the evolution of animals and plants. Thus, to quote only one instance, Darwin writing to Wallace in 1871 and referring to 'missing links,' said, 'I should rely much on pre-Silurian time; but then comes Sir William Thomson, like an odious spectre.' The geologists resisted more firmly. Thus Sir Archibald Geikie, in his Presidential Address at Edinburgh in 1892, concluded his discussion of the subject with these words: 'The geological record furnishes a mass of evidence which no arguments drawn from other departments of Nature can explain away, and which, it seems to me, cannot be satisfactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede.' At the Leeds meeting in 1890 I had many opportunities of meeting Prof. John Perry, and when we were walking together on the Sunday afternoon I asked him to tell me something of the Kelvin-Tait conclusions and how far they must be accepted. He had been a demonstrator under Kelvin and spoke of the intense interest with which he had followed his lectures at Glasgow, and he gave me no hope of escape. His change of opinion, throwing a most interesting light upon the influence of the British Association, was the result of the Presidential Address at Oxford in 1894, when Lord Salisbury chaffed the believers in natural selection, telling them that he did not wonder that they required many hundred million years for so slow a process, but that 'if the mathematicians are right, the biologists cannot have what they demand .... The jelly-fish would have been dissipated in steam long before he had had a chance of displaying the advantageous variation which was to make him the ancestor of the human race.' When Perry read this pronouncement, sweeping aside the firm convictions of biologists and geologists, he was led to re-examine the evidence and soon found a flaw. The heat of the earth had been calculated on the assumption of a conductivity uniform through the whole mass, but Perry showed that with a conductivity becoming higher with increasing depth the Kelvin-Tait estimate of the time required for cooling to the existing temperature—on which the age of the habitable earth had been based—must be immensely lengthened. Perry told me of this destructive criticism and very kindly helped me to make use of it in the address to Section D at Liverpool in which I replied to Lord Salisbury's amusing attack on the evolutionists.

Lord Lister was our President at Liverpool in 1896, and I cannot resist the temptation

to digress for a moment and recall the address in which one of the greatest benefactors of mankind told us, with the utmost simplicity and modesty, the story of his life's work and the success which, in spite of all opposition, had been achieved. To hear him was an enduring inspiration.

The year 1896 was also the Jubilee of Lord Kelvin's wonderful half-century of achievement in research and teaching, and I could not help feeling some regret that any criticism of his work should appear at this particular time. But in the kindly spirit of our Association such doubts were quite unnecessary. I well remember how he came one day to our Sectional Committee-room to bring me some volumes of his works, and how, as I have recorded before, in the following year as we were travelling across Canada after the Toronto Meeting and the chance of collecting insects for a few minutes at each station could not be resisted, Lord Kelvin said to his wife, 'My dear, I think we must forgive Poulton for thinking that the earth is so very old when he works so hard in one day out of all the endless millions of years in which he believes!'[4]

The one line of evidence which left some anxiety in 1896, was suggested by Helmholtz who allowed the sun only eighteen million years to have been giving out radiant heat at the present rate—a period Lord Kelvin was willing to extend to 500 million—and this estimated maximum was also accepted by Sir George Darwin, who, in his address[5] at Cape Town in 1905, spoke of the new evidence obtained by M. and Mme. Curie in their proof that radium gives out heat, and quoting in confirmation the work of R. J. Strutt, W. E. Wilson, and G. H. Darwin, finally concluded that 'the physical argument is not susceptible of a greater degree of certainty than that of the geologists, and the scale of geological time remains in great measure unknown.' The light thrown by radium upon the Helmholtz estimate was also referred to in the Presidential Address of Ray Lankester at York in 1906, of J. J. Thomson, quoting the work of Strutt, Joly and Rutherford, at Winnipeg in 1909, and became a predominant subject in the Joint Discussion on the Age of the Earth, between Sections A, C, D and K, at Edinburgh in 1921.[6] Lord Rayleigh in opening this discussion concluded 'that radioactive methods of estimation indicate a moderate multiple of 1,000 million years as the possible and probable duration of the earth's crust as suitable for the habitation of living beings...'

Even in the present year Sir Ambrose Fleming, in his address to the Victoria Institute, is reported in *The Times* of January 12 to have maintained that 'We were not in possession of any generally agreed scientific modes of geological time measurement, but only with estimates which were based for the most part on personal predilection or guesses at truth.' It is to be regretted that the conclusions of scientific colleagues should be attributed to 'personal predilection,' and as for 'guesses at truth'—what are these but hypotheses; and surely the discoverer whose imaginative effort led to the thermionic valve and did so much to endow the world with the infinite possibilities of wireless—surely he has little cause to choose for the serious efforts of others the word which in this connection carries a suggestion of shallow irresponsibility.

Geologists and biologists do not profess to know the age of the earth as the abode of life, but they are sure that, in the words used by Sir William Turner at Bradford in 1900, its birth 'must have been in the far-distant past, at a period so remote from the present that the mind fails to grasp the duration of the interval'.

I fear that too much of our time has been occupied by the attempt to show that the field is clear for the discussion of Organic Evolution, but until this could be done any such discussion appeared to be well-nigh useless.

It is, I think, a mistake to emphasise too strongly the very natural shock received by many who read the *Origin* or heard of its teaching for the first time and without any preparation; and I believe an even greater mistake to criticise the clergy for the time that elapsed before their acceptance of the new teaching. I shall never forget the reception of Aubrey Moore's paper, 'Recent Advances in Natural Science in their relation to the Christian Faith,' by the Church Congress at Reading in

[4] *Report, British Association, Centenary Meeting*, 1931, p. 78.
[5] *Ibid.*, 1905, pp. 514–18.
[6] *Ibid.*, 1921, pp. 413–15.

1883.[7] No speaker could have carried his audience with him more thoroughly: there was not a single protest or indication of dissent—nothing but enthusiastic applause. The Bishop of Oxford, Dr. Mackarness, was in the chair when the paper received this unanimous welcome—only twenty-three years after the Oxford meeting at which another Bishop of Oxford put his rude and foolish question to Huxley. It is pleasant to know that their celebrated encounter left no bitterness, for Huxley wrote in 1891 to Francis Darwin—'In justice to the Bishop, I am bound to say that he bore no malice, but was always courtesy itself when we occasionally met in after years.'

I remember as a youth receiving a gentle parental warning against committing myself too entirely to a belief in evolution—a very different experience from that of our President at Hull in 1922, my friend Sir Charles Sherrington, who in 1873 was persuaded by his mother to make the *Origin* with him on his summer holiday, with the inspiring words—'It sets the door of the Universe ajar!'

I have recalled Dr. Wright's indignation at York in 1881 as my only experience of opposition to a belief in Organic Evolution at any of our meetings, and the published Proceedings confirm this impression of unanimity. Thus, R. H. Traquair, addressing the biologists at Bradford in 1900, said, 'I hardly think that we should now find a single scientific worker who continues to hold on to the old special creation idea'; and Lord Salisbury at Oxford in 1894, referring to Darwin, said, 'He has, as a matter of fact, disposed of the doctrine of the immutability of species. It has been mainly associated in recent days with the honoured name of Agassiz, but with him has disappeared the last defender of it who could claim the attention of the world.' The mention of this great American naturalist recalls Tyndall's fine address at Belfast in 1874 and his memories of Agassiz's words, 'I was not prepared to see this theory received as it has been by the best intellects of our time. Its success is greater than I could have thought possible.'

Huxley, who had seconded the vote of thanks to Lord Salisbury, wrote to Hooker a few days later: 'It was very queer to sit there and hear the doctrines you and I were damned for advocating thirty-four years ago at Oxford, enunciated as matters of course—disputed by no reasonable man!—in the Sheldonian Theatre by the Chancellor....'[8]

A letter written two days earlier to Boyd Dawkins records Huxley's opinion of another part of the address. 'Lord Salisbury gave himself away wonderfully, but he was so good about Darwin himself that I shut my eyes to all the nonsense he talked about Natural Selection.'[9]

Leaving now the subject of Organic Evolution itself, as generally accepted, I wish to speak on the difficult question of its motive causes which for many years have formed the subject of addresses, discussions and papers at our meetings. The great division into two opposed theories of causation became clear in 1887 when Weismann attended the meeting at Manchester, and a discussion on 'The Hereditary Transmission of Acquired Characters' was held in Section D. From that time evolutionists attending our meetings have been either 'Lamarckians' following Erasmus Darwin, Lamarck, Buffon and Herbert Spencer, or 'Darwinians' who followed Darwin and Wallace. Darwin himself, however, included the Lamarckian conception of 'use-inheritance' as a motive cause, although believing it to be far less important than Natural Selection. The term 'Neo-Darwinian' has therefore been applied to those who, accepting Weismann's teaching, reject 'use-inheritance' altogether.

It must always be remembered that, apart from any theory of causes, the world owes its belief in Organic Evolution to all the great men whose researches and teaching have founded the two schools, and perhaps chiefly, at any rate among the English-speaking nations, to Herbert Spencer. I was first led to realise the extent of his transatlantic popularity when I learned from an American story greatly enjoyed in those far-off undergraduate days, that

[7] *Science and the Faith*, London, 1889, pp. 222–35.

[8] *Life and Letters*, 1900, **2**, 379.

[9] From a letter of August 10, 1894, printed in the *Jesus College (Oxford) Magazine*, for Lent Term, 1928; and reprinted in *Hope Reports*, 1929, **16**, no. 3, p. 6. (Privately circulated to many scientific libraries.) Huxley's letter of August 18, 1894, to Lewis Campbell (*Life and Letters*, **2**, 379) refers to the same subject.

his books were keenly appreciated by a bashful hero, who was so far from sharing the sublime confidence of their author, that he was only led to perform the most fateful action in life by the pressing advice of a very young nephew who assured him, in the presence of the lady, that if he was fond of her, the proper thing to do was to kiss her. Herbert Spencer's infallibility certainly lent itself to such stories as that of his supposed reply to an argument—'That can't be true, for otherwise *First Principles* would have to be re-written and the edition is stereotyped;' or how Darwin said that to read Spencer always made him feel like a worm, but that he retained the worm's privilege of wriggling, and at another time 'wonderfully clever, and I dare say mostly true.' But, allowing for a style which provoked these and other amusing comments, we must never forget that believers in the doctrine of Organic Evolution owe an immeasurable debt to Herbert Spencer.

James Russell Lowell's amusing lines in the *Biglow Papers*[10] appear to prove that Lamarckism was prevalent in America many years before the *Origin*:

> 'Some flossifers think thet a fakkility's granted
> The minnit its proved to be thoroughly wanted,
> Ez, fer instance thet rubber-trees fust begun bearin'
> Wen p'litikkle conshunces come into wearin',—
> Thet the fears of a monkey, whose holt chanced to fail,
> Drawed the vertibry out to a prehensile tail.'

The year of Manchester meeting, 1887, was the fiftieth anniversary, and we are now celebrating the Centenary, of the entry in Drawin's pocket-book:

'In July opened first note-book on Transmutation of Species. Had been greatly struck from about the month of previous March on character of South American fossils, and species on Galapagos Archipelago. These facts (especially latter), origin of all my views.'

It is especially interesting to recall that these views, as Professor Newton told us in his address to D, the Biological Section, did not include Natural Selection which only came into Darwin's mind when he read Malthus, *On Population*, in October, 1838. Newton, who had read the proof-sheets of the great *Life of Darwin*, published later in 1887, then spoke of Wallace's independent discovery, made twenty years after Darwin's, a discovery suggested to him also by reflecting on Malthus, and of the friendship between the two great men to whom this fruitful conception had come, referring the cynic who would 'point the finger of scorn at the petty quarrels in which naturalists unfortunately at times engage' to this 'greatest of all cases, where scientific rivalry not only did not interfere with, but even strengthened, the good-feeling which existed between two of the most original investigators.' And here I cannot resist the desire to quote a part of the speech made by Wallace at the most thrilling scientific gathering I have ever attended—the fiftieth anniversary of the Darwin-Wallace Essay read before the Linnean Society on July 1, 1858, only twelve days after the arrival of Wallace's letter and manuscript from the Moluccas. Wallace then said, on July 1, 1908:

'The idea came to me, as it had come to Darwin, in a sudden flash of insight: it was thought out in a few hours..and sent off to Darwin—all within one week. I was then (as often since) the "young man in a hurry": *he*, the painstaking and patient student, seeking ever the full demonstration of the truth that he had discovered, rather than to achieve immediate personal fame....If the persuasion of his friends had prevailed with him, and he had published his theory, after ten years'—fifteen years'—or even eighteen years' elaboration of it—*I* should have no part in it whatever, and *he* would have been at once recognised, and should be over recognised, as the sole and un-disputed discoverer and patient investigator of the great law of "Natural Selection", in all its far-reaching consequences.'[11]

Amusing evidence of the difficulty with which this 'great law' was understood is afforded by a verse written by Lord Neaves and dated May, 1861:

> 'A deer with a neck that was longer by half
> Than the rest of its family's (try not to laugh),
> By stretching and stretching, became a Giraffe,
> Which nobody can deny.'[12]

Yet Wallace, referring to Lamarck's hypothesis and 'that now advanced,' had written in his Section of the Joint Essay:

[10] The lines are quoted from the First Part, published 1846–48.

[11] *Darwin-Wallace Celebration of the Linnean Society of London*, 1908, pp. 6, 7.

[12] *The Origin of Species. A new song.* In *Songs and verses, social and scientific*, by an old contributor to *Maga. Edinburgh*, 1868, 2 *Ed.*

'Neither did the Giraffe acquire its long neck by desiring to reach the foliage of the more lofty shrubs and constantly stretching its neck for the purpose, but because any varieties which occurred among its antitypes with a longer neck than usual *at once secured a fresh range of pasture over the same ground as their shorter-necked companions, and on the first scarcity of food were thereby enabled to outlive them.*'

There were fortunately others who did not launch such ill-aimed criticism. Thus Professor Newton, reminding the Section that the new teachings had been at once accepted by Canon Tristram[13] before the appearance of the *Origin of Species* (on November 24, 1859), expressed, with all the enthusiasm of one who was devoted to the same delightful branch of natural history, 'the hope that the study of ornithology may be said to have been lifted above its fellows.' It was indeed very fortunate that the Darwin-Wallace Essay should have been read so soon after its appearance by a naturalist who looked on the species question as did Tristram—a great traveller and observer who studied indefatigably the birds he loved, as living creatures and in as many countries as he could visit.

At the last meeting of the British Association in Nottingham (1893) Canon Tristram was President of Section D and, in his address, gave an account of the observations referred to by Newton at Manchester. The historic interest of this early acceptance of Natural Selection is such that I have prepared a brief abstract of his chief conclusions :

During a visit of many months to the Algerian Sahara in 1857–58, he 'noticed the remarkable variations in different groups, according to elevation from the sea, and the difference of soil and vegetation.' On his return he read the Darwin-Wallace Essay and wrote, 'It is hardly possible, I should think, to illustrate this theory better than by the larks and chats of North Africa'. He then explained how the colours arose by selective destruction of birds which harmonized less well than others with the surface of the desert. And similarly with other larks having 'differences, not only of colour, but of structure,' chiefly 'marked in the form of the bill.' He took as instances a very long-billed lark (*Galerita arenicola*), resorting exclusively to the deep, loose, sandy tracts, and a very short-billed allied species (*G. isabellina*), haunting the hard and rocky districts. He then pointed out that there is individual variation in the bills of larks and that the shorter-billed birds would be at a disadvantage in obtaining food from sandy areas but at an advantage among the rocks where strength is required. He concluded, 'Here are only two causes enumerated which might serve to create, as it were, a new species from an old one. Yet they are perfectly natural causes, and such as I think must have occurred, and are possibly occurring still. We know so very little of the causes which in the majority of cases, make species rare or common that there may be hundreds of others at work, some even more powerful than these, which go to perpetuate and eliminate certain forms "according to natural means of selection."'

The temptation to record an amusing incident which happend at one of the meetings of Section D at Manchester, cannot be resisted. Work was proceeding smoothly under the genial guidance of Prof. Newton when, suddenly, Dr. Samuel Haughton of Dublin entered and from the back of the room announced in arresting tones that he had an important communication to make about the animals preserved from the Flood. He believed that Mrs. Noah strongly objected to her husband's intention to take the elephants on board, fearing that their weight would cause a dangerous displacement of the Ark's metacentre. How this domestic difference was composed we had no opportunity of learning, for as the Chairman, whose expression combined sympathetic amusement with mild deprecation, was rising and about to protest, Dr. Haughton, anticipating the result, had already turned towards the door, telling us over his shoulder that he was on his way to make a fuller communication on the subject to the Anthropological Section.

After this brief description of an event, which I hope you will agree ought not to be forgotten, we must return to Organic Evolution and to one of the most important subjects debated at any time before a meeting of the British Association—the question, "Are Acquired Characters Hereditary ?"—brought before the world by Prof. August Weismann, who was present at Manchester and spoke in the discussion (unfortunately not reported),

[13] *Ibis.*, October, 1859, pp. 429–33.

introduced by Ray Lankester, in which Dr. Hubrecht, Patrick Geddes, Marcus Hartog and the present speaker, took part. Weismann's conclusion that 'Acquired Characters' are not inherited, was held by Prof. Goodrich, in his address to Section D at Edinburgh in 1921, to be 'the most important contribution to the science of evolution since the publication of Darwin's *Origin of Species*,' an opinion with which the great majority of biologists will agree, although the terms employed for the two classes, the Inherited and the Non-inherited, together with the ideas underlying them, were shown by Adam Sedgwick, at Dover in 1899, Archdall Reid, and others, as well as by Goodrich himself, to be incorrect. Nevertheless it will probably be impossible to abandon the word 'acquired,' employed by Erasmus Darwin (1794), Lamarck (1809), and Prichard (1813) as well as by later authorities. Whenever environmental conditions are followed by characteristic changes, absent when these conditions are absent; or when such changes follow the use or disuse of the parts of an organism, or the education it has recieved, then we have before us the 'acquired' characters maintained by Weismann to be incapable of hereditary transmission. This vital conclusion, accepted, as I believe it is, by nearly all biologists, is not appreciated as it ought to be by the general public. A brief statement of a single piece of evidence may convince some who are doubtful about a conclusion with which human life is very deeply concerned.

My old friend the late A. A. Macdonell, Professor of Sanskrit at Oxford, spoke two langauges, English and German, as they are spoken by native Englishmen and Germans. I asked whether he thought it was possible for any mature person to learn a foreign language so perfectly that he would be mistaken for a native. He replied that he was sure it could not be done and that his own ability to speak the two languages as he did had been only made possible because as a small child he had been continually taken backwards and forwards between the two countries. Yet any human being transported as a baby from his own country to another and brought up there among the natives will learn to speak as they speak. All the past generations, however many, during which his ancestors spoke the language of his birthplace, will count for nothing, will not retard his acquisition of another tongue or modify it in any way.

An interesting and amusing example is provided by the futile striving of an Englishman to pronounce the Welsh double-l, generally attempted by the substitution of 'th'. And even the advice given by a Welsh clergyman to the English Bishop of his diocese is unlikely to bring success: 'You must put the tip of your Right Reverend tongue against the roof of your Right Reverend mouth, and hiss like a goose.'

The result of education as an 'acquired' character in the Weismannian sense is of such special importance that I think it is well to quote the conclusions stated by Ray Lankester in his address to the seventy-fifth meeting of the Association at York. He then maintained that the 'power of building up appropriate cerebral mechanism in response to individual experience or what may be called "educability," is the quality which characterises the larger cerebrum, and is that which has led to its selection, survival, and further increase in volume'.... '"Educability" can be transmitted; it is a congenital character. But the *results* of education can *not* be transmitted. In each generation they have to be acquired afresh.... On the other hand, the nerve-mechanisms of instinct are transmitted, and owe their inferiority as compared with the results of education to the very fact that they are *not* acquired by the individual in relation to his particular needs, but have arisen by selection of congenital variation in a long series of preceding generations.'[14]

Lankester was led by these conclusions to reject altogether the theory of G. H. Lewes, G. Romanes, and others, 'that instincts are due to lapsed intelligence,' a theory also disproved by Lloyd Morgan's observations on young birds described by him at the Ipswich meeting in 1895.[15] Another very important subject brought forward by Lankester was the evidence, originally published by him in 1894,[16] that Lamarck's first and second laws of heredity 'are contradictory the one of the other, and therefore

[14] *Report, British Association*, 1906, pp. 26–27. The conclusions here quoted had been communicated to *Société de Biologie* of Paris, in 1899 (Jubilee Volume) and were reprinted in *Nature*, 1900, **61**, 624–25.

[15] *Report, British Association*, p. 734.

[16] *Nature*, 1894, **51**, 127; *British Association*, 1906, pp. 29–30.

may be dismissed.' His statement may be briefly summarised as follows:

The first law assumes that in spite of thousands of generations during which a normal environment has 'moulded the individuals of a given species of organism, and determined as each individual developed and grew "responsive" quantities in its parts (characters); yet, as Lamarck tells us, and as we know, there is in every individual born a potentiality which has *not* been extinguished. Change the normal conditions ...and (as Lamarck bids us observe), in spite of all the long-continued response to the earlier normal specific conditions, the innate congenital potentiality shows itself. The individual.....shows *new* responsive quantities in those parts of its structure concerned, new or acquired characters.'

'So far, so good. What Lamarck next asks us to accept, as his "second law," seems not only to lack the support of experimental proof, but to be inconsistent with what had just preceded it. The new character which is *ex hypothesi*, as was the old character··· which it has replaced—a response to environment··· is, according to Lamarck, all of a sudden raised to extraordinary powers. The new or freshly acquired character is declared··· to be capable of transmission by generation; that is to say, it alters the potential character of the species. It is no longer a merely responsive or reactive character, determined quantitatively by quantitative conditions of the environment, but becomes fixed and incorporated in the potential of the race, so as to persist when other quantitative external conditions are substituted for those which originally determined it.'

The effect of Lamarck's laws on the hereditary transmission of acquired characters would be this: 'a past of indefinite duration is powerless to control the present, while the brief history of the present can readily control the future.'

After hearing a very condensed statement of conclusions so essentially bound up with the progress of Organic Evolution, I feel sure that you will wish to be reminded of Prof. Ewing's words which followed the address at York:

'Now is the winter of our discontent made glorious summer by this Ray of Lankester.'

Returning to the unreported discussion on the inheritance of acquired characters at Manchester, I venture to bring forward certain observations opposed to a belief in Lamarckian evolution by means of inherited experience—observations which I then described and have not known to be answered. In the relationship between enemy and prey there is very commonly no opportunity for the latter to learn by experience. The wonderfully elaborate adaptations by which sedentary insects are hidden from enemies have been evolved, not by experience of enemies but by avoidance of enemies. In these examples, and they are numberless, we are driven to accept Weismann's conclusion and with him to invoke 'the all-sufficiency of Natural Selection.' When one of the twig-like caterpillars, of which there are so many in this country, is detected by an insectivorous bird it can do nothing and is devoured at once. Its one defence is the astonishingly perfect resemblance to a twig of the bush or tree on which it lives. It is firmly fixed and its weight also supported by an almost invisible thread so that it cannot escape as many caterpillars do by dropping to the ground and sheltering in the grass or among dead leaves. Its one chance of survival is to gain so perfect a disguise that it will not be seen, and to gain this end the adaptive devices are most elaborate and wonderful: its twig-like shape and colours with the power of gradually adjusting these so as to resemble the bark of the bush or tree on which the parent moth laid the egg from which it came, even the power to reproduce exactly the appearance of lichen, the rigid stick-like attitude maintained during the hours of daylight. Finally, there is the evidence, recently obtained by Robert Carrick,[17] that the disguise *does* protect; for examples of one of these caterpillars, resting on a branch of its food-plant fixed over a Wren's nest containing young, were unnoticed by the parent bird which used the same branch as a convenient perch; yet seen and at once taken when placed on a white surface below.

One of the best examples of a prophetic instinct is to be found in the larva of an

[17] *Trans. Roy. Ent. Soc., Lond.*, May 1936, **85**, Part 4, 131, 3 pls.

African Tabanid fly (*T. biguttatus*). This maggot lives and feeds in soft mud which, during the dry season when the chrysalis stage has been reached, will be traversed in all directions by wide and deep cracks in which insectivorous animals can search for prey. But the maggot, while the mud is still soft, prepares for this danger. By tunnelling spirally up and down it makes a line of weakness which will cause a pillar to separate from the mass when the mud hardens and contracts. It then tunnels into the still soft pillar and becomes a chrysalis in the centre of its deeper end. However, wide the cracks which appear in the mud, the maggot has arranged beforehand that they will not invade its cylinder. Dr. W. A. Lamborn, who made this most interesting discovery, observed that the summits of the pillars, forming circular discs of about the size of a penny, scattered here and there over the surface, were never thus traversed, but that an empty shell was protruding from the centre of each when the fly had emerged.[18] My friend the late Prof. J. M. Baldwin, the distinguished American psychologist, well remembered at many of our meetings, wrote when he heard of this discovery: 'it seems *complete*—one of those rare cases of a single experience being sufficient to establish both a fact and a reason for the fact! It is beautiful.'

I would ask any believer in Lamarckian evolution, or in Hering's and Samuel Butler's theory of unconscious memory residing in the germ-cells, how it would be possible to explain these prophetic instincts, adapted not to meet but to avoid future experience, except by the operation of natural selection.

The appeal to Orthogenesis, or internal developmental force, as the motive cause of evolutionary progress has often been made—generally by palæontologists rather than by the observers of living forms. Any such belief in the potency of an internal tendency is, I think, open to the criticism made by Thiselton Dyer in his address to Section D at Bath in 1888: 'This appears to me much as if we explained the movement of a train from London to Bath by attributing to it a tendency to locomotion. Mr. Darwin lifted the whole matter out of the field of mere transcendental speculation by the theory of natural selection, a perfectly intelligible mechanism by which the result might be brought about. Science will always prefer a material *modus operandi* to anything so vague as the action of a tendency.'

It is not necessary for me to speak on the rediscovery of Mendel's great work and all that it has meant to our Biological Sections in the early decades of the present century. The recent developments, following the work of Haldane, R. A. Fisher, and others, and the vitally important relationship between Mendelism and Natural Selection were brought before us last year in Julian Huxley's illuminating address to Section D. The older belief that only large variations, or mutations as they then began to be called, were subject to Mendelian inheritance, and that small variations were not inherited at all, disappeared when further researches proved that extremely minute differences were 'heritable in the normal Mendelian manner,'[19] and, with this, the foundation of Darwinian evolution became immensely strengthened. It is also right to remember that Bateson, the leader of Mendelian research in this country, always believed in Natural Selection, regarding it indeed as self-evident and not very interesting. Also that Ray Lankester, as long ago as his 1906 address at York, maintained that however far Mendelism was advanced it 'would not be subversive of Mr. Darwin's generalisations, but probably tend to the more ready application of them to the explanation of many difficult cases of the structure and distribution of organisms.'

The relationship between the germinal foundation of Mendelian and Weismannian heredity was considered in a paper by L. Doncaster read before Section D at the South African meeting in 1905. He then maintained that Weismann's 'hypothesis that the material bearer of hereditary qualities is the chromatin of the nucleus' of the germ-cells had been confirmed by recent work on their maturation which 'has shown that they contain a mechanism which seems precisely adapted to bring about that segregation of characters which forms the most fundamental part of the Mendelian theory, and it seems hardly possible that the two things are unconnected.' MacBride also in his address to the same section at Newcastle in 1906, spoke of the 'great epoch-making

[18] *Proc. Roy. Soc.*, B, 1930, **106**, 83, pl. 5; *Proc. Ent. Soc. Lond.*, 1930, **5**, 14.

[19] *Report, British Association*, 1931, p. 77 and references quoted.

discovery of experimental embryology, *viz.*, the existence of SPECIFIC ORGAN-FORMING SUBSTANCES.' These fundamental discoveries bring to mind a conversation with Weismann when he had been finally driven to frame and elaborate this hypothesis, and was so appalled by the number and minuteness of the material bearers of hereditary qualities contained in a single germ-cell that, as he told me, he could not believe that the physicists and chemists were correct in their conclusions about the size of the atom. He admitted that diverse lines of evidence led to the same result, but even so, he believed the future would prove that physicists were mistaken and that the atom was far smaller.

It is impossible to say more than a few words about the very interesting and important discussion on 'The present state of the Theory of Natural Selection' held at the Royal Society on May 14, last year. The subject was approached from many points of view by both zoologists and botanists and their conclusions were very welcome to Darwinians who remembered the earlier opinions expressed when Mendel's great work was rediscovered. I think, however, that Prof. D. M. S. Watson, in the opening address, was inclined to underestimate the value of the existing evidence for a 'selective death rate,' although everyone will agree that 'any new evidence....or indeed any suggestion of cases which might be capable of investigation,' would be most desirable.

I may briefly mention a few experiments brought before Section D at the Bristol meeting in 1898 beginning with the work of Weldon and Thompson on the Common Shore Crab, showing that the effect of china clay and other impurities in the sea at Plymouth was selective and promoted changes of shape which ensured that the water flowing over the respiratory surface was more efficiently filtered.

Then, on the subject of chance, the heroic help rendered by Mrs. Weldon, who four times recorded the result of 4,096 throws of dice, showing that the faces with more than three points were on the average, uppermost slightly more often than was to be expected. It comes back to me very clearly because of the interesting explanation—that the points on dice are marked by little holes scooped out of the faces, and that points 6, 5, and 4, respectively opposite 1, 2, and 3 are somewhat lighter, more of the ivory having been removed; also because of Francis Galton's delight and his humorously expressed wonder whether the facts had been realised by those who had an interest other than scientific in the throwing of dice.

Experimental evidence was also submitted by Miss Cora B. Sanders (Mrs. C. B. S. Hodson) and myself, proving that when the rough angular pupa of the small tortoise-shell butterfly is suspended from a surface against which it stands out conspicuously, it is in far greater danger than when it is fixed to one upon which it is concealed.'

To the observer of living creatures, however, the most convincing evidence is provided by animals themselves. When a wild bird is seen to capture some conspicuous butterfly or moth and then immediately to reject it the association between inedibility and a warning colour is more convincingly suggested than when insects are offered to animals in confinement, although such experiments are of great value and often provide the only available evidence. There are, however, instances in which abundant data for statistical investigation are furnished by the wild animals themselves. Thus the long-eared bat has the convenient habit of eating moths—its regular food—while it hangs suspended from a surface to which it returns after each capture; and as the wings are rejected, these may be collected in large numbers, yielding valuable information on the significance of concealing and warning patterns.

In the attempt to determine the motive causes of organic evolution, the work of the naturalist, the student of living nature, is essential. His task is to do what Lyell did for geology by directing attention to the forces now in operation and seeking with their help to interpret the past, and in this work it is especially valuable to study adaptations which have been developed in recent times and can, in certain instances, be proved to undergo changes even now. Thus the interesting observations of H. Lyster Jameson showed that a pale local race of the common mouse had been formed, although incompletely, in from 100 to 125 years, by the selective attacks of owls and hawks on sandhills near Dublin.[20] I therefore believe that the

[20] *Journ. Linn. Soc.* (Zool.), 1898, **26**, 465, pl. 30.

colours of animals provide one of the most fruitful fields in which to persue these investigations, and I regret that this work has been recently attacked by an American zoologist who, referring to the recent revival of natural selection, continues—'if the doctrine can emerge minus its sexual selection, its warning colours, its mimicry and its signal colours, the reaction over the end of the century will have been a distinct advantage.'[21] It is of course impossible to discuss, on the present occasion, this confident attempt to depreciate the value of work associated with the names of Bates, Wallace, Trimen and Fritz Müller. I will only point out that their conclusions on warning colours and mimicry have been immensely strengthened and confirmed by the later observations of Guy Marshall, W. A. Lamborn, St. Aubyn Rogers, Hale Carpenter, V. G. L. van Someren and others in Africa; by the experiments conducted by some of these naturalists, and also by H. B. Cott and R. Carrick, and in the United States by Morton Jones.

It is interesting to remember that a paper by two American entomologists[22] was among the first to accept and support by fresh observations the conclusions brought forward by H. W. Bates in his great memoir on the mimetic butterflies of the Amazon Valley,[23] and that one of the authors treated the same subject more completely in a later paper[24] much appreciated by Darwin.[25]

It is also important to remember that the above-mentioned conclusions have been reached by the study of marine animals no less than terrestrial, as was shown by Herdmann in his address to Section D at Glasgow in 1901, and by his experiments communicated to the same Section at Ipswich in 1895; also that Garstang, with his very long and intimate experience of marine life, adopts the same interpretation of colour and form with the associated attitudes and movements.

If time permitted it would be possible to speak of numerous papers on mimicry and the related subjects which have been brought before our meetings. It is impossible to attempt this now, but many will feel with me that the name of the late Dr. F. A. Dixey should not be forgotten—one who attended so regularly, so often read papers at our meetings, presided over Section D at Bournemouth in 1919, lectured at Leicester in 1907, always giving the results yielded by the study of his favourite insects, and their interpretations by the theory of natural selection; also one who delighted in the social gatherings of his Section, where his rendering of *Widdicombe Fair* will be long remembered.

In my concluding remarks I am anxious to refer to a very interesting and encouraging subject—the feeling for animals and the care for their welfare to-day, as contrasted with the treatment they received a hundred years ago and even in the youth of many among us. Only last autumn *The Times* of October 12, reported that 1,000 swallows had arrived at Venice 'sent there by bird-lovers from Vienna and Munich in order to save them from the effects of the cold weather. Soon after their arrival they were set free and flew south along the Adriatic coast.' And a little earlier the writer of the amusing 'Fourth Leader' referred to a meeting of the Society for the Preservation of the Fauna of the Empire at which the care of the opossum was discussed, comparing this with the report of happenings a hundred years earlier when there was a 'humorous debate' at the Zoological Society 'about puffing cigar-smoke into the cages of the monkeys,' to their discomfort. The writer, yielding too far, we hope, to the depression of the present day, concludes: 'The world, it may be, is "man-sick" and yearning to be rid of a bad mistake. But the creature cannot be wholly vile when instead of torturing monkeys it takes thought for the opossum.' It would not be right to quote from a century-old report without speaking of all that is done and has been done during many years for the care and health of animals by the great London Society, and in doing this, for the education and happiness of our people. But the change of which I have spoken is most deeply impressed on those who remember, as many of us do, the misdirected hours in youth when birds were shot in our gardens and brick traps made to catch them. I feel sure that those who did

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[21] *Evolution*, A. Franklin Shull. (New York, 1936.)

[22] Walsh and Riley: *The American Entomologist*, St. Louis, Mo., 1869, **1**, 189.

[23] *Trans. Linn. Soc. Lond.*, 1862, **23**, 495.

[24] Riley, *Third Annual Report on the Noxious ..... Insects of ..... Missouri*, 1871, p. 142.

[25] *Charles Darwin and the Theory of Natural Selection* (Poulton, 1896), p. 202.

these things are not essentially different from their children and grandchildren who have grown up in a kinder atmosphere. I must not occupy more time on a subject which to some may seem inappropriate, but it is bound up with education in its true sense —a leading out—and if, as Ray Lankester said at York, and we are all coming to believe, the hidden powers within *are* inherited while the results of their development are *not*, then there is no easing of the burden with the passage of time, but each generation afresh must bear the heavy responsibility of conducting this development in the best way so that its successor may be able to meet the changing and, at this time, the increasing needs. The relationship between the powers within and their development was suggested in arresting words by the late Prof. Scott Holland: 'To say that a man cannot be made good by Act of Parliament is such an obvious truth that people forget what an outrageous lie it is!'

Thoughts on the development of these hidden powers by the educating influence of social environment, suggests the greatest of the problems by which we are faced—the end of international war. Michael Foster, in his Address at Dover in 1899, after speaking of progress in the material of warfare was led to believe that, 'happily, the very greatness of the modern power of destruction is already becoming a bar to its use, and bids fair—may we hope before long?—wholly to put an end to it; in the words of Tacitus, though in another sense, the very preparations for war, through the character which science gives them, make for peace.' And in his concluding pages he expressed the hope that the brotherly meeting between the English and French Associations at Dover and Boulogne might be looked upon as a sign that science, by nobler means than the development of armaments, was steadily working towards the same great end. And, in a time of still greater need and perplexity, may we not, in the same hopeful spirit, look upon the recent visit by which members of the French Association have honoured us, and feel strengthened in the belief that the great end will be reached.

There are, I know, very many people who look upon the Great War with later wars and rumours of wars as the close of Michael Foster's dream. The words in which Sir Arthur Schuster concluded his address at Manchester in 1915, and Sir Edward Thorpe at Edinburgh in 1921, indicate, I hope, that the British Association does not thus despair, and in this belief I bring you a passage from the far earlier address which Sir Richard Owen delivered to the Twenty-eighth Meeting at Leeds in 1858—a passage which makes a special appeal at a time when the British and American Associations are confidently hoping to strengthen still further the bonds of sympathy and mutual appreciation by which they have been happily united for so many years.

Referring to the transatlantic telegraph Sir Richard said:

'We may confidently hope that this and other applications of pure science will tend to abolish wars over the whole earth; so that men may come to look back upon the trial of battle between misunderstanding nations, as a sign of a past state of comparative barbarism; just as we look back from our present phase of civilisation in England upon the old border warfare.'

Confident words inspired by the forging of a new link between the two great English-speaking nations. Nearly eighty years have passed since they were spoken, but with all the terrible disappointments there has been great progress, and a time will surely come, and may it come quickly, a time which shall prove that the visions of the young and the dreams of the old were prophetic of a glorious reality.

Fig. 2.

Female *Pristomerus testaceicollis*, Cam.

occupies the second place among the enemies of *Holcocera* in Ranchi. In Bangalore it is rare or almost unknown and does not also compete with *Apanteles fakhrulhajiæ* in Sohagpur.

Incidentally, it may be remarked that the selective association of *Holcocera* and its parasites with *Lakshadia mysorensis* and its exclusion from the fauna associated with *Lakshadia communis* indirectly speaks for the existence of two different species of lac insects where the season and locality remain the same.

The illustrations were undertaken with the financial help of the Hyderabad State and I have to thank Nawab Fakhur-yar-jung Bahadur, Finance Minister, for his kind interest.

S. MAHDIHASSAN.

American Express Co.,
Berlin,
May 26, 1937.

[1] *Societas entomol.*, 1930, **45**, 47.
[2] *Ind. For.*, 1909, **35**, 31.
[3] *Ind. For. Mem.*, 1910, **1**, Pt. 3, Plate 2, Fig. 4 and Fig. 4*a*.
[4] *J. Sci. Assoc.*, Vizianagram, 1925, **2**, 81.
[5] *Ann. Rep. Ind. Lac. Res. Inst.*, 1934, 25.

On the Introduction of *Euphorbia geniculata* Ort. in India.

IN *Current Science*[1] I read the article on this plant by Mayuranathan. It is suggested that *E. geniculata* was introduced in 1891 from the Kew Botanic Gardens.

I am specially interested in this plant because of its occurrence in the Netherlands Indies, where it is also of recent introduction as far as we know, and where it is also used as a purgative matter. Here it has been imported at least twice from different sources, which I have discussed in a previous publication.[2]

The earliest record of *Euphorbia geniculata* for India is much earlier than Mayuranathan suggests, as Hooker in the *Flora of British India*[3] (1886), has already mentioned it. He writes, "The American *E. geniculata*, Orteg. (*E. prunifolia*, Jacq., Wall. Cat. 7690), is both cultivated in gardens, and has been found apparently wild, but no doubt as an escape in the Sutlej Valley". This seems to indicate that already Wallich, who published his Catalogue in 1828, had known the plant to occur in India.

C. G. G. J. VAN STEENIS.

The Herbarium of the Botanic Gardens,
Buitenzorg, Java,
August 4, 1937.

[1] *Curr. Sci.*, 1934, **3**, 254.
[2] *Natuurkundig Tijdschrift voor Nederlandsch India*, 1936, **96**, 133.
[3] *Flora of British India*, 1886, **5**, 239.

Fresh Locality Record for *Euphorbia geniculata* Ort. in South India.

AFTER the publication of my note to *Current Science* No. 3 of 1934, I have collected *Euphorbia geniculata* from the following localities. At Dronachalam in Anantapur District I saw it growing in coriander fields. It has overrun the whole of the Sheveroys reaching within a few miles of Salem town. It is ubequetous in coffee estates and in the prepared soil of plantations it grows to a laxuriance that I have not noticed elsewhere. On the borders of Grange Estate I found this plant growing in strikingly dense groups to the exclusion of other herbs. It occurs in compounds at Chikmagalur in the Malnad of Mysore Province.

P. V. MAYURANATHAN.

Government Museum, Madras,
September 6, 1937.

REVIEWS.

Zero to Eighty. By E. F. Northrup. (Published by Scientific Publishing Co., 46, Park Place, Princeton, New Jersey.) Price $. 3·0. Foreign $. 3·5.

This is an imaginative autobiography of a fictitious individual living from 1920 to 2000 A.D. The principal character of the story, Akkad Pseudoman, has the boyhood ambition of going on a trip to the moon and returning alive to the earth. The story is developed in such a way that this youthful dream of creating a means for escaping the earth's gravity, circling round the moon, and returning alive with records to the earth, is finally realised. The book is divided into an autobiographical narrative and a technical supplement. All technical descriptions, scientific proofs, etc., are given separately in the technical supplement, while the first part of the book is made as interesting as possible and suitable even for a layman who has no knowledge of mathematics. The narrative is written in an excellent style and is so interesting that one wants to finish it at a reading.

The technical supplement deals with such topics as, the general laws of motion; the work required to overcome the gravitational attraction of the earth; the parabolic velocity; the thrust given to a projectile by an electric gun, use of the thrust constant in the design of the electric gun, the theory of linear propulsion by travelling magnetic waves, etc., and the book contains many excellent photographs and drawings. The author has tried to prove that the views expressed in the earlier part of the book are quite within the possibility of being carried out, provided one has the money and the determination to achieve it.

The autobiographical narrative is divided into 35 chapters. In the earlier portions, the principal character Akkad Pseudoman describes his boyhood days and how, he gradually develops into a fine young man. He was lucky in having a very level-headed father, who gives him an ideal education and develops both his body and mind. The young man, after graduation from the High School, goes to Europe and cultivates the friendship of a fine girl Marie (whom he later marries), and of her brother, Jean, with whom he later on makes the trip to the moon. In the early part of his career, Akkad inherits a fortune from one of his relatives and discovers an old disused Red Indian gold mine which places him in a very comfortable position regarding his finances. Having a plentiful supply of money and being endowed with good scientific training he sets about realising his youthful dream of circumnavigating the moon. For this purpose he mainly depends on the use of electrically produced travelling waves of magnetic force.

All the resources at the disposal of Akkad are used to perfect a mechanism, which would take him and his friend and co-worker Jean near to the moon and back. During the course of their work they form a club called 'The Weft-Warp Club', consisting of six members in addition to Jean and Pseudoman. The author uses these members to express his views on various diverse topics. An idea of the topics discussed may be gained by the fact that the membership of the Club included an expert on aviation, a philosopher, a biologist, an expert on military matters, a journalist reporter, and an explorer, in addition to Jean who was an engineer and Akkad Pseudoman, a practical scientist.

Akkad Pseudoman has perfected an electric gun, and in the course of a lecture before the Weft-Warp Club he shows that it is humanly possible, by employing polyphase electric currents in combination with rocket propulsion, for two persons to go along the line between earth and moon in a hermetically sealed projectile beyond the pull of the earth's gravitation. He gives a model of a two-dimensional spaceship and the technical supplement gives more details about such things.

The book, as a narrative fiction, is full of human interest, and the publishers' claim that it is unusual and original in its conception and presents a reasonable scientific solution to the problem of escaping the earth's gravitational attraction and navigating projectile-ships in celestial space is certainly well-founded;—by far an outstanding book.

B. S. B.

Lectures on College Algebra. By S. B. Dandekar, Privatdozent, University of Delhi. (Published by Vinayak & Co., Indore City.) Price Rs. 3 or 5*s*.

The author who styles himself, in an unusual way, as a *privatdozent* of the University of Delhi has tried to write a *new* text-book on Algebra for Intermediate students, and claims to have put in original matter in different ways. The result is very disappointing and the book is thoroughly bad. The reviewer has searched in vain for a single commendable feature of the book.

First of all it must be mentioned that the language is hopelessly ungrammatical, and in places it is very difficult to make out the author's meaning. The following few extracts from the Preface serve to bring out this point, and can safely be recommended to a teacher who wants to place before his students some examples of bad English :

(1) "Secondly, among then who, capable of swallowing, anyhow stand this trial, become the time-honoured mathematicians along with those who so encourage them."

(2) "The mode of treatment accordingly is made as succinct, to the point and direct statement of facts, as the boy, who has just joined college and wishes even newly to learn the subject, should be able to grasp it only if he keep his sense work as for any other subject."

(3) "Thirdly and the unique feature of the book has been to adopt a central thought into the fabric of which are woven the tissues into the fabric of which are woven the tissues of material from the topics developed in the several chapters, shaping them into a choherent whole the one body of knowledge."

These sentences defy all attempts at grammatical analysis.

As regards the content and the mode of treatment, the less said about it the better. The book is full of errors, and unless these are eliminated and the proofs recast totally in a subsequent edition it is dangerous to recommend this book to students. Some of the mistakes are enumerated below :—

P. 8. "A surd is any quantity whose root cannot be found."—According to this definition 2 and 3 would be surds.

P. 19. "A ratio denotes the relative strength between two magnitudes."

P. 269. "An infinite series, whose terms are alternately positive, and negative, is convergent if each term is numerically less than the preceding term."

P. 295. "The proof claimed to be original is insufficient. It should be stated that it makes the truth of the theorem plausible."

P. 312. "Ex. 45. We shonld have $\log_b a$ and not $\log_e a$."

P. 328. "For the proof of the theorem that the number of solutions common to two equations is equal to the product of their degrees, the book that an Intermediate student is referred to is Salmon's *Higher Plane Curves*."

The book contains a good number of examples which include many set for the several examinations in our country, and these examples can be carefully used by a teacher.

K. V. I.

Plane Trigonometry. By Simmons and Gore. (John Wiley & Sons, New York ; Chapman & Hall, London.) Pp. 201 + pp. 81 of tables ; Price 20/-.

This is an excellent text-book for beginners in trigonometry. It eliminates certain objectionable features of our existing text-books such as (1) excessive number of examples often of the same type ; (2) incorrect treatment of some important portions such as inverse trigonometric functions, etc.; (3) insignificant mention of the periodicity properties of these functions ; (4) over-emphasis on artificially constructed examples and ignoring the practical aspect of the subject.

The only disadvantage from the point of view of the existing syllabus of our Universities for the Intermediate course is that the properties of triangles are not treated so fully. Perhaps, in America they teach those portions with geometry. The comparatively high cost of the book is to be explained by the fact that it contains an unusually comprehensive table of 81 pages containing the logarithms of trigonometric functions to five places at *interval of a minute*, besides the usual things in the tables of ordinary text-books of trigonometry.

The book is warmly recommended to the libraries of our Intermediate Colleges and can be used as a text-book by the students.

K. V. I.

Introduction á la Théorie des Fonctions de Variables Réelles. Parts I and II. By Arnaud Denjoy. (Actualités Scientifiques et Industrielles, Nos. 451 and 452.)

In recent years, it has become customary to publish mathematical monographs treating special topics on modern mathematical thought, many of the monographs being smaller than the text-books used in our primary schools. We are having before us two such pamphlets on the theory of real variables. To those mathematicians whose interests primarily lie in other branches of mathematics, these pamphlets provide ready means of knowing the essential developments of the subject, and the clarity of exposition so characteristic of French authors adds to their usefulness. (However, detailed proofs of the theorems will not be expected in such pamphlets each of which contains less than 60 pages. The present reviewer is too conservative in order not to frown at this omission which habit is prevalent among certain schools of writers, and which converts such publications into shorthand notes of lectures that could be delivered before semi-specialised audiences.) To persons who are familiar with voluminous treatises on the subject, these books are no less welcome on account of the succinct exposition giving an aerial survey of the entire field, as well as on account of the novel view-points in many places—to be expected, of course, from such a distinguished writer.

Part I deals with sets of points, continuity and differentials. The measure of a set according to Jordan, and according to Borel-Lebesgue is explained and generalised for a measure of order q in space of p dimensions. The mean *épaisseur* of a set E is defined, and Lebesgue's theorem on its existence for a measurable set E is set forth. The author gravely remarks against the use of the word *density* which most writers use for what he calls *épaisseur*, because the topological notion of density is often altogether of an opposite nature. In the next chapter measurable functions, continuity, approximate continuity and absolute continuity are explained, and there is a brief note on the approximation of continuous functions by polynomials.

In Part II, the first chapter expounds integration theories as per Riemann, Lebesgue, and Stieltjes, and more briefly Denjoy's and Perron's generalisations. The next chapter treats of trigonometric series and includes convergency and summation problems, conjugate Fourier series and multiplication theorem of two Fourier series together with a note on orthogonal and biorthogonal series. The next chapter explains the conception of quasi-analytic functions according to Borel and according to Bernstein. The book concludes with a brief chapter on functionals.

C. N. S.

L'Algebra Abstraite.—By O. Ore. (Actualité's Scientifiques et Industrielles No. 362.) (Hermann & Co., Paris.) Pp. 52. Price 15 *fr.*

This is an introduction to modern algebra. It does not contain the proofs but acquaints the reader with the definitions and notions of modern algebra—such as Ring—Modul—Group—Ideal—Isomorphism—Homeomorphism, etc. Incidentally, the hyper complex systems and representations of a group also are touched by the author. Some important theorems which were discovered recently are also included by him such as the theorem of Remak which forms a simple and elegant extension of the second Isomorphie theorem in group theory. At the end the author gives the list of text-books for further study.

K. V. I.

La Topologie de Groupes de Lie.—By E. Carton. (Actualite's Scientifiques et Industrielles No. 358.) (Hermann & Co., Paris.) Pp. 26. Price 10 *fr.*

This is a short monograph dealing with the topological properties of the space of operators of a Lie-group by Elie Cartan who has devoted his entire life with remarkable success to the development of continuous groups and allied geometrical concepts. It contains a number of interesting theorems on the structure. One or two of them are given here as illustrations :—

(1) In the space of a compact simple Lie-group every closed variety which does not contain a singular element is homotop zero.

(2) The first two Betti-numbers of such a group are zero.

(3) The first Betti-number of an open simple group is either 0 or 1.

At the end of the monograph he gives a complete Bibliography.

K. V. I.

Solar Eclipses.

[*Eclipses of the Sun and Moon.* By Sir Frank Dyson and R.v. d.R. Woolley, *The International Series of Monographs on Physics.* (Clarendon Press, Oxford), 1937, pp. viii + 160; 15*sh.*]

THE accidental circumstance that the Sun and the Moon have very nearly the same apparent diameters as seen from the Earth converts what might otherwise be a rather trivial astronomical phenomenon into a thrilling spectacle and a magnificent scientific opportunity. The total obscuration of the Sun's disk by the Moon when it occurs brings about a dramatic change in the appearance of our luminary. The overpowering light of the Sun's photosphere and the consequent illumination of the Earth's atmosphere are both shut off with the result that the solar atmosphere and its appendages, namely, the chromosphere, the prominences and the outlying corona with its streamers, suddenly stand revealed. The field of stars surrounding the Sun can also be seen or photographed. For the last one hundred years, the scientific value of the opportunities for investigation provided by a total solar eclipse has been steadily and increasingly realised. No fewer than some fifty organised expeditions to observe total solar eclipses have been made during these years. As the total phase is observable only over a restricted area of the Earth's surface, the investigator has to travel to distant parts of the Earth, sometimes even to remote and uninhabited places. Much effort and expense is involved in getting together and setting up the elaborate instrumental equipment necessary, and in endeavouring to make the best possible use of it during the few precious minutes of the total phase. Everything, of course, depends upon the sky remaining unclouded during that brief interval. The observers have, in fact, to go hoping for the best and prepared for the worst of weathers. One cannot but admire the scientific enthusiasm which evokes and sustains effort under such difficult conditions.

It is a remarkable fact that the stream of new knowledge which has resulted from eclipse expeditions has, at the same time, led to the development of methods by which phenomena which at first could only be observed at such times can now be studied as a matter of daily routine under ordinary conditions. The invention of the spectroheliograph and the spectro-helioscope, has, for instance, made it possible to keep the forms of the solar prominences continuously under observation. The bright line spectrum of the solar chromosphere may nowadays be photographed in full daylight under favourable conditions. Quite recently, also, Lyot, by using special optical equipment and a high level station for his observations, has succeeded in photographing the corona and has also secured spectroheliograms of it in the light of its green line radiation. These developments, however, so far from diminishing the interest of eclipse studies have rather enhanced them, if one might judge from the number of expeditions organised from all sides to make use of the specially favourable opportunities provided by each successive eclipse of the Sun.

It is now fully fourteen years since the American astronomer Mitchell wrote his well-known volume on "Eclipses of the Sun". During the interval, of course, the subject has advanced greatly and numerous technical publications of great importance have appeared. The monograph now under review gives a compact and at the same time comprehensive and stimulating account of the knowledge that has come to us from the study of the lunar and solar eclipses. The earlier chapters of the book deal with the prediction of the time of eclipses and with important connected topics such as for example, the secular acceleration of the longitudes of the Moon and the Sun and their dynamical explanation. The seventh chapter contains a very clear statement regarding the observed deflection of star-images by the gravitational field of the Sun. From this account, it appears that Einstein's prediction from his general relativity theory is verified by the observations. This chapter should be of special interest to those readers in India who may have been inclined to give credence to the numerous reports and publications emanating from Allahabad regarding the alleged demolition of Einstein's theory of relativity. The subsequent chapters give a very clear account of the methods and results of eclipse studies of the solar atmosphere. Chapter XII contains an interesting discussion of the dynamical theory of the

chromosphere put forward by Dr. S. Chandrasekhar. The last five chapters deal with the unsolved problems of the corona and discuss various aspects of the subject, namely, the forms of the corona, the intensity and polarisation of the coronal light, its spectrum and the origin of the entire phenomenon.

The attractive way in which the whole subject has been handled, the beautiful and well-chosen illustrations and the excellence of the account given of the more important recent developments, make the reading of this book a pleasant and profitable undertaking. Its appeal should extend far beyond the circle of specialists interested in astro-physics. Indeed, the reviewer has no hesitation in recommending the volume as one that should be read by every aspiring young physicist who wishes to imbibe the spirit of scientific research and discovery. The book brings out clearly the dominating rôle which physics plays in present-day astronomy.

C. V. RAMAN.

ASTRONOMICAL NOTES.

Planets during October 1937.—Mercury will be visible as a morning star during the early part of the month and will reach superior conjunction with the Sun on October 29. Venus will continue to be a bright object in the eastern sky before sunrise. On October 11, the planet will be very close to Neptune, the distance being only about three-tenths of a degree; the phenomenon can be seen with the aid of a small telescope.

Mars and Jupiter will be prominent objects in the sky immediately after sunset. The two planets will be approaching each other and on October 29, the angular distance between the two will be only one and a half degrees. Jupiter will attain quadrature with the Sun on October 12.

Saturn who is in opposition to the Sun on September 25, will be moving westwards in the sky and can be seen practically throughout the night. The ring ellipse is again getting edgewise, the major axis being $43''{\cdot}8$ and the minor axis $2''{\cdot}4$. Uranus will be about $2°$ west of the star σ Arietis (magnitude $5{\cdot}5$) and will cross the meridian an hour after midnight.

Comets (1937 *f*) which was discovered by Finsler in July, increased in brightness and has since become visible to the naked eye. At the beginning of September, it was in the constellation Bootes and moving southwards. Comet Whipple (1937 *b*) is gradually decreasing in brightness but is still within the reach of moderate instruments. Another new comet (the seventh for the year 1937) is reported to have been discovered on August 4 by Dr. Hubble at Mount Wilson (U.S.A.). At the time of discovery, the comet was faint, of magnitude 13,—and situated in the constellation Aquarius. It is moving in a southwesterly direction; from the computed ephemeris, it is found that the comet is approaching the earth, so that an increase in brightness may be expected.

Nova Herculis and the three novæ discovered last year are still bright enough to be observed with small telescopes. Nova Herculis is slowly declining, its magnitude on September 8 was $8{\cdot}6$. With powerful instruments, the star has been found to be a close double, the separation being about $0''{\cdot}6$ in March 1937. The distance between the components appears to be gradually increasing; the measures obtained during the last two years are discussed by Kuiper in a paper in the *Astrophysical Journal*, July 1937. No appreciable change seems to have happened in the brightness of Nova Lacertæ since June. On September 8, its magnitude was $10{\cdot}7$ while that of Tamm's first nova in Aquila has definitely declined to $11{\cdot}5$.

CENTENARIES

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Fludd, Robert (1574–1637)

ROBERT FLUDD, the British physician, was born in 1574 in a parish of Kent. Having become an M.A. of the University of Oxford in his twenty-fourth year, he studied medicine for another six years in France, Spain, Italy and Germany and returned home with considerable reputation as a Chemist. He became M.D. in 1605 and a Fellow of the College of Physicians in 1609.

The Extent of His Knowledge

He practised medicine in London. His success in the healing art is ascribed to his influence on the minds of his patients, producing a 'faith-natural' which aided the 'well-working' of his drugs. He always had an amanuensis by his side to whom he dictated at odd hours his numerous and elaborate treatise on 'things divine and human'. He had unusual mechanical skill; by his own account he had constructed a wooden bull that bellowed, an automatic dragon, and a self-performing lyre. He is supposed to have been the first inventor of the barometer—an honour usually attributed to Toricelli.

His Place in Science

Fludd was the chief English representative of the mystic school of medicine which claimed to have found out the key to universal science. According to him the Bible, especially the Book of Moses, contained all the necessary hints for modern science. All true science was, according to him, rooted in Revelation. These views involved him in controversies with men like Kepler. He was a believer in the four classes of elemental spirits—salamanders, sylphs, nixes and kobolds—by whom the respective phenomena of fire, air, water and earth were created. He dwelt much upon the real or supposed analogy between the human body and the whole universe—the microcosm and the macrocosm. He was an apt embodiment of the conflicting tendencies of his times—a period, which in order to escape from the trammels of Aristotelian scholasticism pressed forward on the one hand on the track of experimental research and on the other sought to resuscitate the wildest dreams of neoplatonists—and of the cabala.

His Publications

Fludd was a prolific writer. As many as sixteen of his books were published. He wrote under various names including the anagram Rudolf Otreb. His works were collected together in 1538 under the title *Opera*.

The End

Fludd died unmarried on September, 1637, at his house in London. He was buried with some ceremony. A monument, for which he had left instructions, was erected with an epitaph and a bust in 1638. His portrait represents Fludd as a man with bald head, high forehead and good features.

Galvani, Aloisio (1737–1798)

GALVANI, a celebrated Italian physician who shares with Volta the honour of having given his name to several terms connected with electricity, was born at Bologna on September 9, 1737. In his younger days he studied theology, but having been dissuaded by his friends from entering into an order of monks, he turned his mind to medicine. In 1762 his thesis *On the bones, their nature and their formation*, attracted favourable notice, and secured for him the Readership in Anatomy at the Institute of his city. His lectures were attended by crowded audiences and he soon established a high reputation not only by his surgical skill but also by his researches into comparative anatomy, particularly the organs of hearing and genito-urinary tract of birds.

Animal Electricity

But it is an accident that linked Galvani's name with electricity and immortalised it in several electrical terms. The accident happened in 1790. Various versions of this accident are given in text-books. The common factor of these versions is that he observed convulsions in a cut frog whenever a spark was taken from the prime conductor of an electrical machine. This led Galvani to the discovery of animal

electricity, which he published in 1791 in a work entitled *Aloysii Gelvani de Vribus Electricitatis in Motu Musculari Commentaries.* According to Volta, who announced this "fine and grand" discovery in the *Philosophical transactions* of the Royal Society of London in 1793, "this subject, under the name of Galvanism, has given occasion to several important discoveries".

His End

The death of his wife, in 1791 followed by other misfortunes, arrested Galvani's scientific researches and threw him in a deep melancholy. During the political troubles in Italy, he was mercilessly deprived of all his offices and compelled to retire in a state of extreme bodily infirmity to the house of one of his brothers. Subsequently, the republican leaders seem to have been ashamed of their severity to a man who had shed lustre upon his country and passed a decree for his restoration to his offices and emoluments, but it was too late, and Galvani died on 5th December 1798, about a year before Volta enriched science, by the discovery of the battery, which first rendered Galvanism a power, and established its identity with electricity.

Ritchie, William (1790–1837)

WILLIAM RITCHIE, the British physicist, was born about 1790. He was educated for the church and was first licensed to preach. But he soon abandoned the church for the teaching profession and became the rector of the Royal Academy of Tain, Ross-shire. By extreme frugality, he contrived to save a sufficient sum from his very small annual stipend. This enabled him to provide a substitute to perform his duties and go to Paris to attend a course of lectures of Gay-Lussac, Biot and others.

His Scientific Career

His skill and originality in devising and performing experiments with the most simple materials, in illustration of various disputed points of natural philosophy, attracted the attention of the distinguished scientists, whose occasional pupil he had become. He became known to Sir John Herschel and through him communicated to the Royal Society papers entitled *On a new photometer, On a new form of differential thermometer* and so on. These papers attracted the attention of Major Sabine, who secured for him in 1821 the professorship of natural philosophy at the Royal Institution. After three years, he became the Professor of Natural Philosophy at the London University.

His Publications

Subsequent to this he communicated several papers to the Royal Society, of which he was elected a Fellow. They covered torsion balances, theories of Galvanism, electromagnetism and Voltaic electricity. His memoirs were more remarkable for the practical ingenuity shown in the contrivances and execution of the experiments than for theoretical value.

Optical Glass

Ritchie was subsequently engaged in experiments, on an extensive scale, on the manufacture of glass for optical purposes and a commission was appointed by the Government to inquire into his results and to their further prosecution by a public grant of money or by affording increased facilities of experiment by a relaxation of the regulations of the excise. But the performance of the glass was not found so satisfactory as to sanction further expenditure.

The End

Ritchie died on 15th September 1837 of a fever caught in Scotland. Though the traces of an imperfect and irregular education were manifest in his theoretical researches, he was an experimenter of great ingenuity and merit and a remarkable example of the acquisition of a very extensive knowledge of science under difficulties and privations which would have arrested the progress of any person of less ardour and determination of character.

INDUSTRIAL OUTLOOK.

The Indian Glass Industry.

By E. Dixon, A.M.I.Mech.E.,
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THE manufacture of glass in India is probably of great antiquity although until quite recently the practice of the art appears to have been confined almost entirely to the making of spangle glass and glass bangles rather than to the manufacture of blownware utensils. The rapid perfection of the technique of glass-blowing in Syria immediately prior to the Christian Era, a technique which is believed to have originated at Sidon about the third century B.C., and which, through the agency of the Syrian blowers, soon spread throughout the Roman Empire, founded the great glass houses of Alexandria and Rome, and later sent skilled Syrian workmen to the more modern but equally famous glass industries of the Rhineland, Venice (Murano), Spain, France and England, apparently left India untouched. Practically no blownware was made in this country until the end of the nineteenth century. This is more than strange when it is remembered that many famous and beautiful pieces, chiefly domestic vessels, originated in Persia and Egypt during the Middle Ages. One explanation is that glass was commonly supposed to contain bone-ash as an essential constituent and this undoubtedly helped to make its use unpopular in India.

Early Indian glass appears to have been made exclusively by fusing the alkaline earths, *Reh** which are common throughout the country in the plains, and there is no evidence that potash and soda for the manufacture of high class "metal" were made from wood and seawood, as was done in the early days of the industry in other countries. Spangle glass manufacture and, more particularly, bangle-making, have undoubtedly been practised for many centuries in a desultory fashion wherever *reh* deposits occur.

Ancient Branches of the Industry.

Spangle Glass.—At the present time indigenous spangle glass is made only at Panipat in the Punjab, although Sir George Watt in his *Dictionary of the Economic Products of India* (1890) speaks of nearby Karnal as being a centre for this industry.

* Chiefly silica and crude sodium carbonate.

The method of manufacture consists of fusing together 'red stone', a form of sandstone from Agra District, *sajji*,† an alkaline earth similar to *reh* obtained from Bahawalpur State, and *shora* or saltpetre obtained locally, and blowing the resultant glass into globes which are 'silvered' internally.

The sandstone is first broken down by heating in kilns and crushing. The materials are then mixed together and melted in crude, wood-fired, tank furnaces of archaic design. The refractory bricks for the furnaces are made from an aluminous clay obtainable locally, and are sun-dried after moulding and bonded by the inclusion of straw. When the furnace is fired the bricks are fused to a certain extent and so attain some mechanical strength. The furnaces are extremely wasteful of fuel but are interesting as relics of an ancient technique.

	%	
Loss on ignition ..	16·35	(Representing moisture, organic matter, carbon dioxide and volatile salts.)
Silica	40·80	"The excess over 100% is presumably due to the fact that the loss on ignition was determined separately, and consequently possibly included some loss of alkali salts by volatilisation. This loss has not been taken into account in the final analysis resulting in duplication of this alkali."
Iron oxide ..	3·76	
Titania	0·50	
Alumina.. ..	10·84	
Copper oxide ..	0·13	
Lime	7·80	
Magnesia	2·33	
Sodium oxide ..	13·90	
Potassium oxide ..	3·54	
Chloride	1·68	
Sulphuric anhydride ..	0·73	
	102·26	

The glass made is very high in alkalies and, of course, strongly coloured by the iron and other impurities. It is blown into globes which are 'silvered' internally by coating with an alloy which usually consists of fifteen parts by weight of lead to one part of tin. The globes, after 'silvering', are broken into small mirrors and spangles, and sold for the decoration of buildings or fabrics. Most of the spangle glass goes to the North West Frontier Province, Baluchistan and Sind, but the

† Analysis of sample of *sajji* made at the Government Test House, Alipore, Calcutta.

demand is decreasing and the industry appears to be dying out. In 1936 the value of the industry was estimated at approximately twenty thousand rupees annually.

Cottage Bangle-making.—The art of glass bangle-making is probably the oldest surviving branch of the Indian glass industry. The bangle has always been a favourite adornment of Hindus, and the manufacture of bangles was one of the first uses to which glass was put in this country. As practised to day by the cottage bangle-makers all over India, but particularly in the United Provinces and the Bombay and Madras Presidencies, the same methods and materials are used as were used hundreds of years ago.

Bangles are made by the villages as a part-time employment. *Reh* is fused in open fire-clay pots or crucibles, usually about four in number and containing anything from a few seers to a maund or more of glass. The pots stand in a ring on the ground, and are heated by a wood or charcoal fire in a pit excavated from the earth in the centre of the ring. They are covered by a crude fire-clay dome which is provided with an opening in front of each pot for the removal of the glass, and through which the smoke from the fire escapes. There is no chimney. A few simple coloured glasses are produced by the addition of the *reh* of coloured earths found in the neighbourhood, or of iron rust (green) or crushed coal (amber).

A bangle is shaped by taking out from the crucible a small quantity of molten glass on the end of a pointed iron rod, and then working the end of the rod through the glass so as to form a thick ring. The ring is afterwards expanded down a fire-clay cone until the correct diameter for the bangle is attained. Sometimes the outer face of the bangle is embellished by imprinting a rough geometric design upon it while the bangle is on the cone. A carved wooden die is used for this purpose and is simply pressed round the circumference of the bangle. The bangles are not specially annealed after making, but the method of manufacture does not involve chilling the glass to any appreciable extent so that the bangles on completion are in a partly annealed condition. Skilled bangle-makers can work with extraordinary rapidity and some of them produce as many as 1,000 bangles a day.

The *desi* bangles just described are very crude and are nowadays looked upon with disfavour by all save the very poorest of the people, or those living in isolated districts: the factory-made or imported glass bangle is generally preferred.

The Bangle Industry at Firozabad.—Firozabad, a town in the United Provinces near Tundla with a population of about twenty thousand, is almost entirely given over to the manufacture of bangle glass and bangles. The great demand for glass bangles in India has produced here a large body of men, the *Shishagars*, descended from those who made *desi* bangles from the local *reh* deposits, who have succeeded in concentrating almost the entire factory-made bangle industry of India in the town. Not only are the great majority of the Indian factory-made bangles produced at Firozabad, but large quantities of block glass are also made there for sale to the *desi* bangle furnaces all over the country. (By re-melting Firozabad glass, the cottage bangle-makers can produce bangles which, although crudely formed, are superior to those made from *reh*. These bangles are still of inferior quality, nevertheless, as with the very low temperatures available in the cottage furnaces the glass has to be made readily fusable by the addition of a high percentage of alkalies, and it is consequently lacking in lustre and 'tinkle'.) It is estimated that the total value of the bangle and bangle glass industry at Firozabad is in the neighbourhood of Rs. 30 lakhs annually.

The factory-made bangles of Firozabad set a much higher standard than the *desi* bangles both for finish and 'metal' as the glass is made in coal-fired furnaces, provided with chimneys and, moreover, the *Shishagars* have a very high manipulative skill and are experts at producing beautifully coloured glasses. The best varieties of Firozabad solid multicoloured and hollow silvered bangles (these bangles are sprayed with silver nitrate after forming) can hold their own with imported Japanese bangles of the same types; but both Indian and Japanese bangles are inferior to those imported from Czechoslovakia. Pressed bangles from Czechoslovakia (a type of bangle not yet made at Firozabad) have recently become very popular in India.

Although Firozabad factory-made bangles are greatly superior to *desi* bangles they are by no means yet as perfect as they

might be. This is largely due to the fact that the furnaces in which the glass is melted, known colloquially as 'Japanese' furnaces, are direct fired pot furnaces without means of air preheating. In these furnaces the temperature of the glass rarely exceeds 1200° C., and consequently a high percentage of alkalies have to be used to secure ready melting. The glasses are, therefore, lacking in the much prized ring or, 'tinkle', and tarnish rapidly. Since the chief alkali used is soda ash, a chemical not manufactured in India, the glass is also relatively costly, and the cost is still further increased by the fact that the furnaces are thermally inefficient and consume large quantities of coal. The bangles are made on a semi-mass production scale, but much of the equipment used is cumbersome and inefficient. A description of the process commonly practised will be of interest.

Glass is collected from one of the glass pots in the furnace on the end of an iron rod. If multicoloured bangles are to be made, the gob of glass is shaped on a 'marver', a kind of anvil, into a rough block or 'parison', with as many sides as there are different colours to be added to the original block. During this operation the glass remains attached to the rod. Quantities of various other coloured glasses are then obtained from other parts in the furnace by the same method and are roughly welded to the various facets of the original glass block, which is reheated at "glory-hole", a small reheating furnace, from time to time if necessary.

When the glass 'parison' is ready for the manufacture of bangles it is taken over, still attached to the rod, to a man known as a *tarwalla*, who is seated in front of an open furnace. Holding the rod the *tarwalla* reheats the 'parison' and draws out the end of it into a thread by attaching it to another iron rod which is passed through the furnace to him. The thread of glass is then drawn out over the fire and attached to an iron roller on the far side of the furnace. This roller is mounted on a steel shaft which is supported in semi-circular notches in two wooden posts, one on either side of the furnace and it is wound rapidly by another man, the *belanwalla*, by means of a small crank-handle. One of the notch bearings is threaded and engages in a thread on one end of the shaft. When the *belanwalla* winds the crank-handle a transverse motion is imparted to the roller by the thread in the supporting post, and the glass is wound on to the roller in the form of a spiral.

The success of the operation depends upon the skill of the *tarwalla* who has to maintain an even tension on the glass thread, and he does this by moving the glass near to, or further away from the fire as required at the same time imparting the necessary tension. When a multicoloured bangle is being made he has to show still more dexterity by twisting the 'parison' as the glass is wound off.

When the glass spiral has been completely wound on to the roller the thread of glass is cut by another worker who then lifts the roller and spindle from its bearing at the end distant from the *belanwalla* and removes the glass coil by means of a hooked iron rod. The coil is next broken into a series of open rings by scratching it down its length with a piece of carborundum. The ends of the separate rings, or bangles, so formed are afterwards joined in the flame of a kerosene or petrol lamp.

One of the principal defects of Indian bangles of this type is due to the fact that during the joining process the side of the bangle opposite to the joint is often discoloured by the joining flame, as the flame used is too large and not sufficiently hot. The crudest method of joining bangles practised at Firozabad consists of blowing air by means of hand-driven blower, down a length of piping fitted with a series of jets. The air is simply blown through the flames of kerosene or petrol lamps. Another more efficient method consists of blowing compressed air from a hand bellows through a container in which is a small quantity of petrol, the vapour being burnt in burners similar to those just described.

Hollow bangles are manufactured by blowing in a mould glass 'parison', roughly the shape of a bottle, and then drawing this out into a tube which is wound on to the roller in the usual way. After removing from the roller, the end of the hollow spiral of glass is attached to a bellows, and by this means a colouring material such as cadmium sulphide or copper oxide is blown through the spiral while it is still hot.

Bangles are not annealed after making, and they are usually not packed, but are merely strung together in lots of six or a

dozen pairs. It is an interesting experience to visit the godown of a large bangle factory at night. By the light of a lantern the godown with its thousands of richly coloured bangles, strung together and piled in glistening heaps on the floor, is like some fabled Alladin's cave.

Subsidiary to the Firozabad bangle factories are the bangle cutting and decorating works. Here glass bangles are decorated with patterned facets cut on small grinding wheels. After cutting, the facets are painted with liquid gold, or 'china glass', an opaque glass which is powdered, mixed with water and applied as a paint, and the bangles are then dried in small muffle furnaces. Bangle decorating is also carried on at Firozabad as a cottage industry on a considerable scale, and some of the bangle factories do their own decorating.

So much for the ancient branches of the Indian glass industry. What of the modern?

The Modern Glass Industry of India.

The manufacture in India of glass utensils by methods comparable with those at present practised in industrial countries commenced in 1892. Between that date and the outbreak of the Great War in 1914, when there were three factories in existence, a number of works were operated for short periods without much success, and the industry did not enjoy any real prosperity until the War prevented the importation of glassware from Germany and Austria. Under the stimulus of high prices and immunity from competition the industry flourished for a space, and in 1918 twenty factories were working. But other countries had also been developing their glass industries during this period, and soon after peace was signed the Indian glass industry was feeling the effects of keen competition, particularly from Belgium, Czechoslovakia, and the rapidly industrialising Japan.

The early factories were under European management, and some employed European trained executives, but few of the latter adapted themselves successfully to Indian conditions, and their places in the industry were taken by a number of Japanese blowers and 'experts'. The industry, which has never been properly organised nor attained the degree of perfection on the technique of glass manufacture achieved by the importing countries, bears to day the stamp of the Japanese more clearly than any other influence, and nearly every glass works contains what are colloquially called 'Japanese' furnaces, direct fired pot furnaces provided with chimneys.

At present the industry is located in five main areas, the United Provinces, Bengal, the Bombay Presidency, the Central Provinces, and the Punjab, and there are about forty factories in existence for the manufacture of blownware, as distinct from the twenty or more bangle factories and numerous cottage bangle furnaces at Firozabad.

(*To be continued.*)

Indian Science Abstracts.

THANKS to the efforts of the National Institute of Sciences, India, the publication of an annotated Bibliography of scientific work done in India has been accomplished. The Bibliography for 1935 was published in two parts, the last part appearing in May last. The success attained in this venture is as much due to the commendable organising ability of the General Editor, as to the co-operation of the scientific workers in India.

In any effort of such a magnitude especially, if it be the first one, some omissions are inevitable. The General Editor informs us that references to a large number of papers published in Mathematics, Dairy Science, Engineering Science and probably some other sciences also, do not appear to have been included in the publications. Scientific workers are requested to look through the two parts that have already appeared and send abstracts of such of the papers published in 1935 as have not already found mention to the General Editor. It will be appreciated that for making this work complete, the co-operation and help of the scientists in India is essential.

RESEARCH ITEMS.

On Modular Functions and Dirichlet's Series with Eulerian Products.—Hecke (*Math. Ann.*, Bd. 144, pp. 1–28) has investigated the generalisation of the product formula of Dirichlet's series corresponding to various modular functions. In a previous article in the same journal he had discussed the number of linear independent Dirichlet's series which had certain analytic properties and were characterised by a functional equation. The Euler-product developments that he determines here is not a product in the ordinary sense but it is a product in a matrix ring connected with the totality of modular functions belonging to a certain class. It is interesting to note that many important results in the theory of quadratic forms with rational coefficients of even order can be derived from his results. He proposes to devote another article to these questions which we await with interest.

He considers functions $f(\omega_1, \omega_2)$ analytic in ω_1 and ω_2, which possess the following properties:

(1) in $\omega_2 \neq 0$, $R(\tau/i) > 0$, where $\omega_1/\omega_2 = \tau$, f is one valued and regular in τ except for poles;

(2) $f(\lambda\omega_1, \lambda\omega_2) = \lambda^{-k} f(\omega_1, \omega_2)$

(3) f is invariant for all substitutions

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} \equiv \begin{vmatrix} 1 & 0 \\ 0 & 1 \end{vmatrix} \bmod (Q).$$

where Q is any integer. [This group is denoted by G (Q)]. If M is any substitution out of G (1). then $\phi = \omega_2^{-k} f[M(\omega_1, \omega_2)]$ is a periodic function of τ with period Q $\therefore$ we will have

$$\phi = \sum_n a_n e^{2\pi i \tau n/Q}.$$

Then it is further supposed (4) that this series contains only a finite number of negative terms. If we denote $\omega_2^{-k} f(\omega_1, \omega_2) = f(\tau)$, then $f(\tau)$ should be regular with respect to $z = e^{2\pi i \tau/Q}$ at ∞ and at the rational corners. Functions possessing these properties are designated as integral modular forms by him of the type $(-k, Q)$. Those among these that vanish at the corners is called a corner form. In this article he considers mainly the properties of functions of type $(-k, 1)$ and the investigation for any Q which is connected with quadratic forms with integral coefficients of even order is to be discussed by him in another article. The proofs are rather technical and his main results are the following. [If $\phi(s) = \sum \frac{a_n}{n^s}$, then $\phi(s)$ is called the corresponding Dirichlet's series.]

(*a*) To every complete system of linearly independent Modular forms of type $(-k, 1)$, $F\rho(\tau)$, (K in number) there exist K matrices B^v of degree k with numerical coefficients (which are commutative with one another and which form a complete matrix ring) such that the corresponding Dirichlet's series

$$\phi^\rho(s) = \sum_{n=1}^{\infty} a^\rho(n) n^{-s} \text{ form a matrix}$$

$$\Phi(s) = \sum_{v=1}^{k} \phi^v(s) B^v = \sum_{1}^{\infty} \lambda(n) \eta^{-s}$$

[$\lambda(n)$ is a matrix] which has an Euler product of the following type:

$$\Phi(s) = \prod_p [E - \lambda(p) p^{-s} + p^{k-1-2s} E]^{-1}$$

for R $(s) > k$, where E is the unit matrix of order k.

The Dirichlet's series considered here can be made independent of the modular forms by being characterised as follows:

(1) $(s - k)\phi(s)$ is an integral function of finite order;

(2) $R(s) = (-1)^{k/2} R(k - s)$ where $R(s) = (2\pi)^{-s} \Gamma(s)\phi(s)$.

(In an earlier article it was shown by him by utilising the theory of modular forms that there exist only a finite number of such Dirichlet's series of that type which are linearly independent.] A Dirichlet's series which satisfies these conditions is $\zeta(s)\zeta(s - k) = \sum \frac{\sigma_{k-1}(\eta)}{n^s}$ where $\sigma_{k-1}(\eta)$ is the sum of the $(k - 1)$th powers of the divisors of n. He has shown also how a conjecture of Ramanujan which was proved by Mordell can be included in these general results.

K. V. I.

Inter-atomic Distances in Molecule.—The inter-atomic distances in simple organic molecules are constants, which depend only upon the nature of the bonds. A large number of organic molecules can, however, exist in more than one state, which are all in resonance with each other. In such molecules each inter-atomic distance assumes an intermediate value between the various possible limits. About two years ago, Pauling and Brockway pointed out that if an empirical curve is drawn connecting up the expected constant values with the actually observed distances for some well-known cases, then this curve can be used to estimate the degree of resonance in any new case from the observed deviations from expected values. As the precision of this method largely depends upon this empirical curve, Pauling and Brockway have recently redetermined (*Journ. Amer. Chem. Soc.*, p. 1223), the carbon-carbon distances in thirteen simple non-resonating type of hydrocarbons by the electron-diffraction method. It is found that the C-C distance is remarkably constant in all these cases at 1·54 Å, the hitherto accepted value. But the C = C distance constant requires a slight modification to 1·34 Å, being 0·04 Å less than the value given in the literature.

The results show further evidence of the extraordinary extent to which the tetrahedral carbon atom of vant Hoff and LeBel determine the structure of organic molecules. The values found for the angle between two single C-C bonds, are in all cases (excepting cyclopropane) within 2° of the tetrahedral angle 109° 28′. Another striking observation is that in cyclopropane, in spite of the strain due to distortion of bond angle from 109° 28′ to 60°, the C-C bonds are not weakened and there is no consequent increase in the bond distance.

M. A. G.

Viscosity of Liquid or Plastic Monomolecular Films.—Myers and Hartins (*J. Chem. Phys.*, 1937, **5**, 601) have described two instruments for measuring the viscosity of surface films. They call one of them the capillary slit surface viscometer; this is the two-dimensional analogue of the capillary tube viscometer. The second device for the measurement called the torsion ring surface viscometer, is based on the damping of the torsion pendulam. They have worked out the theory of the instruments and found a general agreement with experimental results. As a result of their investigations, they conclude that the viscosity of a surface film is much more dependent on the tightness of packing of the molecules in the film than upon the number of carbon atoms in the chain.

K. S. G. D.

Coal Conservation in India.—In a symposium on 'Coal Conservation in India' held in the early part of the year under the auspices of the Geological Mining and Metallurgical Society of India (Bull. No. 1, 1937) various aspects of coal industry have been discussed. Regarding the actual reserves of high grade coal suitable for metallurgical processes, a strong case has been made out, to get correct estimates of available coal to safeguard against possible shortage in future. Two important suggestions have been made—the formation of a 'Coal Issue Board' to control production and thus nationalise the industry,—the starting of a 'Fuel Research Board' for the proper utilisation of all grades of coal, the cost of maintaining these bodies being met by a small cess on coal mined annually. Several points regarding state legislation to prevent mine disasters, mine fires and underground labour have been discussed and valuable suggestions offered.

Fossils of the Lower Siwalik Beds.—In the first Yale North India Expedition a few fossils belonging to the Unionidæ were identified in the lower Siwalik beds. In the course of a more recent visit to this area, the expedition has collected more fossil unionidæ from the Chinji zone of the lower Siwaliks and some from the Tatrot and Dhok pathan zones. An account of these has recently been published by Prof. H. E. Vokes of Yale University (*Geol. Min. Met. Soc. Ind.*, Vol. **8**, No. 4). The fossils are rather imperfectly preserved. Five new species have been identified, and described with illustrations.

Note on the Osteology of Palaeopropithecus.—Sometime back Prof. G. L. Sera of Naples published a monograph on the morphology of the extinct Lemur of Madagascar palæopropithecus. Several inferences as to the primitive aquatic adaptations of Mammals were drawn on the basis of this study. Alice Carleton criticises (*Proc. Zool. Soc. Lond.*, 1937, **107**) some of the findings of Prof. Sera. The early workers like Standing and Grandidier, having studied the appendicular skeleton and fragments of skulls, distinguished forms like Megaladapsis, Bradylemur, Hadropithecus and the problematical Palæopropithecus. Prof. Lamberton considerably added to our knowledge later. According to Carleton, the femur and tibia ascribed by Prof. Sera to Palæopropithecus may rightly belong to Archeolemurinæ and as regards the limb bones Prof. Sera discovered in the clavicle a powerful sternocleido mastoid and the lodgement in a hollow of the bone of an aerial sac. This has been now correctly identified as the fibula of Megaladapsis corresponding exactly to the description of Prof. Lamberton.

Maxillary Teeth and Blood Preferences of *Anopheles hyrcanus* var. *sinensis*.—The habits of the Chinese Anophilone, *A. hyrcanus* var. *sinensis* which appears to vary its food preferences according to the locality in which it is found were examined by T. L. Chang (*Lingnan Sci. Journ.*, 1937, **16**, 435), with a view to determine the food preferences of this animal. The findings from precipitin reactions alone are not sufficient to distinguish the groups of anophelines in regard to their food habits. Examination of their maxillary indices should be carried on simultaneously. Two batches of *A. hyrcanus sinensis* collected from rooms where examples of the various natural resources of blood were assembled were examined and the results apparently show no correlation between food preferences and maxillary indices. A high maxillary index (as 17 in *A. maculipennis*) is said to indicate shortage of animal hosts and an overflow of such zoophiticanophilines into human habitations but in the present instance, though the maxillary index is as high as 17, the blood preferences appear to indicate that the mosquito is essentially zoophilic and only attacks man when severity of competition forces it to do so.

A New Boloceroidarian from Brackish-Water near Madras.—N. Kesava Panikkar (*Proc. Ind. Acad. Sci.*, 1937, **B 5**) describes in detail the morphology and asexual reproduction of *Boloceractis gopalai* n.g., n.sp. The mesenteries of the Actinian are not sharply differentiated into macrocnemes and microcnemes; the gonads are borne by the later cycles of imperfect mesenteries, the perfect ones being typically sterile. Asexual reproduction takes place in the anemone by a process of regeneration of deciduous tentacles, the sphinctered partitions at their bases playing an important rôle. The habits of the anemone are given and the systematics of the anemone are discussed in detail.

Titanium Dioxide and its Industrial Applications.*

TITANIUM DIOXIDE is the latest, and in some respects, the most spectacular introduction to the field of white pigments. It has only been used generally in industry for about 15 years, but already the world-wide consumption runs into tens of thousands of tons per annum, and a substance which a decade or two ago was a laboratory curiosity, is now in daily use in many different industries. Titanium dioxide is generally manufactured from ilmenite, which is obtained from several different geographical areas, one of the best known sources being Travancore.

The ilmenite is dissolved in sulphuric acid to form the sulphates of iron and titanium. A portion of the ferrous sulphate crystallises out and is separated, the rest remaining with the titanium sulphate until after the latter is hydrolysed to form a hydrated oxide from which it is then removed in settling tanks or on filters. The purified titanium compound is then calcined at a temperature above 800° C. and finally ground to a particle size suitable for the various consuming industries.

Titanium dioxide depends for its industrial applications mainly on three outstanding properties. Its dominant chemical characteristic is its inertness or inactivity. It may behave as a base or as an acid, but generally shows no trace of reaction with any of the wide variety of materials with which it comes into contact during utilisation. A second important feature is its non-poisonous character. It has, indeed, been eaten in considerable quantities in order to demonstrate its complete freedom from any harmful effect on the human organism.

The dominant physical property, on which many of its uses depend, is its high refractive index, and for this, figures falling between 2·55 and 2·70 are quoted by various workers. This figure is far above the refractive index of any other material, and places titanium dioxide in a class by itself. The amount of light that is scattered at an interface between two materials of differing refractive index, is a function of the difference in their indices. If a suspension of titanium dioxide in a medium of lower refractive index such as oil, rubber, water, cellulose, etc., is compared with a similar suspension of another pigment having a much lower refractive index, it will be found that owing to the much greater scattering of light in the titanium suspension, this will appear much more opaque than the other. Titanium dioxide shows no selective absorption, and a suspension of the pigment in air or any other medium will, therefore, be free from any colouration due to the pigment.

Not only, consequently, will the titanium suspension be more opaque, but it will also have a very intensely white and brilliant appearance. Owing to the fact that titanium dioxide has such a powerful effect in suspensions, it is found throughout the range of industries in which it is employed that much smaller quantities of this pigment will suffice to produce a desired effect than would be necessary if less powerful white pigments were used.

In many articles, particularly rubber, paper, linoleum, paint, etc., the addition of pigments is found to have an undesirable effect on the mechanical properties, the changes induced being embrittlement or loss of flexibility and extensibility. The use of titanium dioxide in place of other pigments enables such deleterious effects to be reduced to a minimum.

Three main grades of the pigment are available in India, namely, the commercially pure oxide, containing approximately 98% of titanium dioxide; the Standard 'T' grade, containing approximately 25% of titanium dioxide and 75% of Blanc Fixe (barium sulphate), and the C. 30 grade, containing approximately 30% of titanium dioxide and 70% of calcium sulphate (anhydrite). Where technical performance is of great importance, the pure oxide should always be used although its price is higher than those of the reduced grades Standard 'T' and C. 30. The oxide is usually cheaper in terms of unit performance. Where apparent cheapness is a dominant factor, the C. 30 grade is sometimes more welcome, although it is generally inadvisable to use this grade in aqueous mediums, where it may be replaced by the Standard 'T' grade.

The applications of titanium dioxide in various industries are dealt with in detail below :—

Paints.

For ordinary oil paints, the reduced Titanium Whites, Standard 'T' or C. 30 may be suitable owing to the fact that, in such paints, considerable amounts of extender pigments such as blanc fixe or barytes are commonly employed. In high class enamels, where it is desired to keep the pigmentation low in order to maintain the gloss as high as possible, the pure oxide should be used, and this will generally be in association with zinc oxide. The pure oxide will also be used in nitro-cellulose and similar lacquers where the final dry film is extremely thin and the maximum cover must be obtained with the minimum amount of solid pigment.

Printing Inks.

In printing inks, the final dry film is extremely thin and it is always necessary to ensure perfect obliteration of the background with one printing impression. Pure titanium oxide must, therefore, be used in nearly all cases. It is important to remember that in many printing inks as well as in many other mediums such as rubber, paint enamel, linoleum, leather finish, paper,

* Abstract of a paper given by Dr. G. F. New, before the South Indian Science Association, Bangalore, on Thursday, 18th February 1937.

etc., titanium oxide is used to impart opacity rather than whiteness in the majority of products and is used largely in coloured articles as well as in whites. Thus a wide range of coloured printing inks must contain titanium oxide, if they are to have good covering power. The usual medium in printing inks is linseed oil which has been thickened by means of heat treatment to a viscous state, and this is known as lithographic varnish.

Leather Finishes.

These are usually made by specialist firms and sold to tanneries or leather finishers. If sold in the wet form, they may contain either glue or casein as the adhesive. If in the dry form, they will be based on casein. For these materials also, it is important to obtain maximum cover both in whites and in all kinds of tints with the minimum of pigmentation and the pure oxide should be used. It is necessary to obliterate the colour of the leather by means of finish without masking the texture. If other white pigments are used, a thicker coating must be employed, with the result that, not only is the texture hidden, but also the finish is more liable to crack.

Vitreous Enamels.

The incorporation of from 6% to 10% of titanium oxide in the frits used for enamelling gives greatly increased resistance to chemical action, both alkaline and acid. Examples of alkaline action are the loss of gloss which takes place on enamel baths, etc., and by the incorporation of titanium oxide, the life of the gloss can be multiplied by five. Acid attack is met with on all domestic vitreous enamelled ware, table tops, cooking utensils, refrigerators, etc., and usually the action of a cut lemon surface results in a definite loss of gloss in a few hours. If titanium is used, it is quite easy, however, to make enamels which will stand the action of a cut lemon for at least 100 hours. A further important advantage in this connection as in many others, is that titanium is completely non-poisonous, whereas some other ingredients in enamels which it will replace are poisonous.

Cement and Artificial Marbles.

In the manufacture of artificial cement and other composition tiles and flooring, titanium oxide or one of the reduced pigments is used for whitening the surface layer. In magnesium oxychloride compositions, it is the only white pigment which is permissible, owing to its resistance to chemical attack.

White and Coloured Rubber Goods.

For the expensive type of rubber materials such as white hospital sheetings and elastic products such as shoe components, the pigmentation must be low to avoid loss of elasticity or flexibility. Titanium oxide is, therefore, used for this purpose not only in white products but also for obliterating the colour of the rubber base in all tinted products.

Casein and Synthetic Resin Plastics.

For incorporation with such moulding materials to make white or light coloured articles, titanium oxide is generally the best pigment owing to the fact that it involves least embrittlement of the finished product.

Paper.

The oxide is the only grade of titanium pigment which should be used owing, again, to the danger of reduction in mechanical properties when larger proportions of weaker pigments are used, tensile strength and folding resistance being the chief which might suffer. The usual procedure is to add the titanium oxide in the form of a water slurry to the beater after the addition of the resin and before the addition of the alum to the finish. Too much, rather than too little alum should be added, as this promotes retention of the pigments. Retention in the actual finished paper will probably not rise above 60% to 70% of the added pigment, depending on local conditions unless there is a back water system which enables the pigment which passes through the wire to be recovered. The addition of a small percentage (up to 5%) of titanium oxide to paper will greatly decrease the weight of the paper necessary to give a desired opacity. Thus in an office paper, it has been found that the presence of 3·9% of titanium oxide gives an increase in opacity of approximately 70%. It is used in white and in coloured papers, particularly for Air Mail, catalogue, magazine and similar products where weight is of predominating importance.

Soap.

The use of up to 2% of titanium oxide on the weight of the soap greatly enhances the appearance of the product, and removes any mottling. It is being widely used in toilet soaps, especially for whites.

Cosmetics.

Titanium oxide is superior to older pigments such as zinc oxide used in toilet articles, both in covering power and freedom from harmful effects on the skin. Titanium oxide also adheres better than other whites.

Textile Printing.

Titanium oxide is used in two types of textile printing :—(*a*) *Ordinary.*—Here the pigment is made into a paste with suitable adhesive, glue, casein or albumen. Titanium oxide is used not only in whites but in all colours in order to give covering power with a minimum solid addition to the fabric. (*b*) *Discharge printing paste.*—The addition of a small proportion of titanium oxide to discharge pastes which are used to produce a white pattern on a dyed background increases the whiteness of the pattern and improves the finished appearance.

Impressions of the Royal Botanic Garden, Kew, London.

By K. P. Biswas, M.A., F.R.S.E.,

Royal Botanic Garden, Calcutta.

THE glorious spring beauty of the Royal Botanic Garden, Kew, prompts me to give a brief account of these famous gardens. A 'Host of golden Daffodils', Narcissus, and Tulips growing in the lawns and mounds are a feast for the eyes. The Magnolias, the Japanese Cherries, and the Azaleas are harbingers of the spring which reaches its climax in the blooming of Rhododendrons in their full splendour. The artistic beds of annuals in front of the Palm House with the background of the lake and its fountain at the centre is the favourite spot of the visitors. The display of colours in these flower-beds, stretching from one end of the lawn to the other, illustrates the high standard of modern horticultural skill (Fig. 1).

The Royal Botanic Garden, Kew, maintains a highly trained Staff of horticulturists, arboriculturists, alpine gardeners, propagators and so on, whose activities are in these days becoming more and more specialised, like those interested in other branches of Science and Art. These members of the Staff are responsible for upholding the standard of gardening reached at Kew during its evolution for a period of one hundred and seventy-seven years.

Frederick, Prince of Wales, secured the help of Kent, the celebrated landscape gardener, and made a successful attempt to convert here, at Kew, his private garden into a good model for a garden in those days. After his demise his widow Princess Augusta of Saxe Gotha, mother of George III, commenced laying out, in an area of nine acres, a botanic garden in 1760, with the aid of John Stewart, 3rd Earl of Bute as Scientific Director, William Aiton as Head Gardener, and Sir William Chambers as Architect. King George after his mother's death in 1772 enlarged this area considerably and with Sir Joseph Banks at his service he introduced many foreign plants. In 1840, the Garden was given to the nation by Queen Victoria. In 1841 Sir William Hooker, the then Professor of Botany at Glasgow, was appointed Director of the Botanic Garden at Kew. During Sir William Hooker's period the Garden attained an area of 250 acres, and subsequent additions brought the Garden to its present area of a little over 280 acres. The Garden thus secures the reputation of being the largest Botanic Garden in the World.

The Royal Botanic Garden, Kew, like the Royal Botanic Garden, Calcutta, lies along the bank of a river stretching from North-East to South-West. Kew Garden has six gates. The main gate on Kew, Green, the cumberland, the Victoria and the Lion Gates on Kew Road; and two Brentford and Isleworth Ferry Gates, on the side of the river Thames.

Kew Garden, associated as it is in its earlier period with the Royal family, retains still in its Kew Palace (built in 1631) a monument of English history. Kew Palace was erected on the foundation of "Dairy House" by Samuel Fortrey. Dairy House belonged to Dudley, Earl of Leicester, favourite of Queen Elizabeth and the husband of Amy Robsort. Dudley was staying here when his ill-fated wife met her tragic death at Cumoron on September 8, 1580. George III acquired the property in 1781 and after the Kew House, was pulled down, it was used as a Royal residence. Queen Victoria's father, the Duke of Kent and his brother Duke of Clarence, afterwards William IV, were both married in July 1818 and their mother Queen Charlotte died in one of the rooms on the first floor, in the following November. The sundial on the lawn in front of the Palace marks the spot where in 1775 Bradley, the Astronomer Royal, made two important discoveries—the aberration of light and the nutation of the earth's axis. His discoveries and astronomical observations are commemorated by this sundial placed by H. M. the King, William IV.

The Queen's Cottage near the Isleworth Ferry Gate is a small thatched cottage. This is another historical place which, as its name suggests, used to be a summer tea-room of George III and Queen Charlotte. It was built by George III in 1760. The grounds were given by Queen Victoria to the public in 1897 with the expressed desire that they should be maintained in their present wild state. This is one of the favourite spots of the visitors when bluebells are in full bloom during the middle of May. The long association of Kew Garden, ceased with the death of the Duke of Cambridge in 1904. The Duke, like his father, resided in Cambridge Cottage, part of which building is now Museum No. IV.

Museums and other buildings.—The Royal Botanic Garden, Kew, possesses four large museums of great educational value. In these museums are arranged exhibits representing various useful aspects of Botanical Science. Museum No. I (Fig. 2) in its exhibits elucidates the uses of Dicotyledonous plants such as Quinine (cinchona), rubber (*Havea brasiliensis*), etc. Museum No. II was opened in 1848, ten years earlier than Museum No. I, to illustrate the economic uses of Monocotyledonous plants. In Museum No. III are displayed various samples of foreign timber, models of indigo plantations in India in olden days, a model of Taitokuin Shrine or Mausoleum of the second Shogan of Japan, many examples of wood craft and various other botanical specimens of public interest. Museum No. IV is mainly devoted to illustrating British Forestry and various uses of British timbers. The Pagoda (built in 1761–62), Temple of Aeolus (1760), Temple of Bellona (1760), Ruined Arch (1759–1760), are objects of antique interest. The Japanese Gateway is a piece of remarkable carving presented to Kew by the Japanese. It is a replica of the famous gateway at Kayoto in Japan, known there as "Choku-Shi-Mon", the Marianne North Gallery contains a collection of 848 paintings executed by Miss Marianne North. The scenes and vegetation of the tropics were painted on the spot. She made a gift in 1882 to Kew Garden of all her lifeworks, together with the building that houses them. King William's Temple

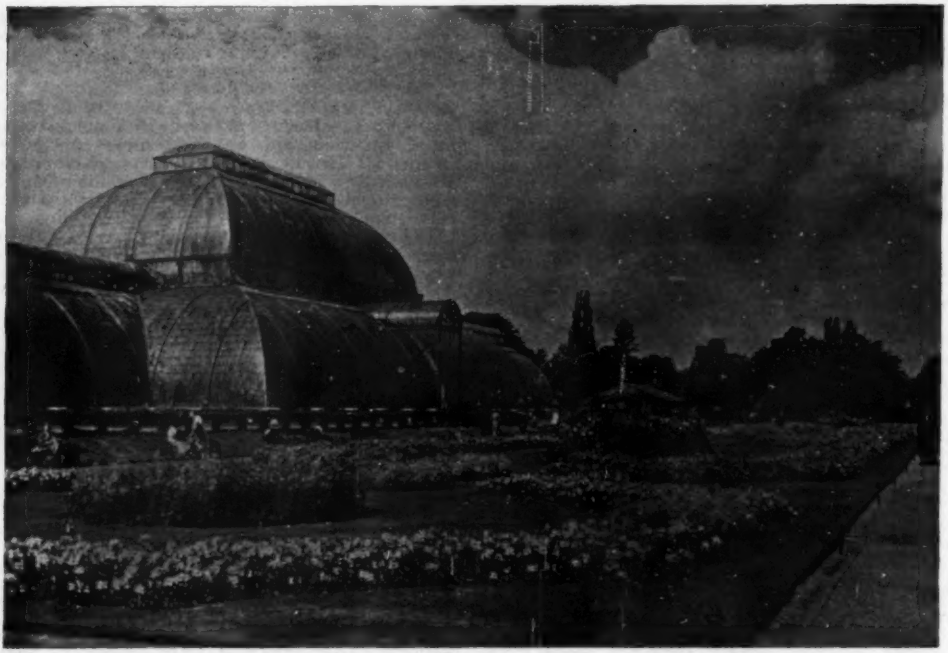

Fig. 1.
The Palm House and the Flower-beds in front of the Palm House.

Fig. 2.
Museum No. I, with the Small Pond and adjacent Flower-beds.

was built in 1837 and in its vicinity is found the attractive group of heath plants of the family of Ericaceæ. The flagstaff of Kew is 214 feet high, cut of Douglas Fir of the Forest of Vancouver Island. The tree itself was 280 ft.–300 ft. high when it was felled.

Kew is equally rich in having a large number of hot and cold houses and ferneries for growing plants coming to Kew from all over the world. The Aroid House provides shelter for many of our familiar Indian Arums. The tropical Fern House is a repository of many rare ferns including the well-known gold and silver ferns and the famous Malayan stag-horn fern. The Temperate Fern House represents among others the rare Gleichenias of Australia, West Indies and New Zealand. The large Palm House is a proud possession of Kew (Fig. 1). In this Palm House are cultivated various species of palms including cocoanut palm, double cocoanut, screwpines (pandanus) and others. Among plants of Indian interest are seen Hemp, Bananas, Mango, Coffee, Cocao, Bael (*Aegle Marmelos*) and others. The travellers tree of Madagascar (*Ravenala madagascariensis*) is also seen in its proper form here. A number of Conservatories are stocked with a good variety of plants displaying the flowering period of the different species in different seasons. About 1800 species of Orchids are grown in the Orchid Houses. Among the common European and American species are found many Northern Asiatic and Himalayan species. Extensive horticultural manipulations are carried out on these much-prized plants by growing them from seeds and bulbs and producing many rare hybrids exhibiting a wide range of variation in colour and texture of the flowers. The Orchidologists differentiate these delicate varieties by coining queer and romantic names and keeping their trade secrets and trade marks to themselves. Similar horticultural operations are practised on other popular flowering plants such as Rhododendrons, Azaleas, Cherries, Prunus, Begonias, Calceolaria, Cyclamen, etc. The Himalayan House, forming a part of the Temperate House or Winter Garden, stocks many alpine species of Rhododendrons, Camelias from China and Japan, Primulas and a few other Northern Asiatic species (Fig. 3). The Begonia House is set apart for specialisation of many rare and gorgeous garden varieties and forms of considerable commercial importance. Cape House, among many of its plants from the Cape of Good Hope, offers good accommodation to the queer plant known as Mesembryanthemums of much interest to botanists. The Succulent and the South African Houses contain many succulent prickly pears and other species of Cactus. Some of the succulents mimic each other and also the pebbles among which they grow (Fig. 4). These xerophytes are grown under conditions resembling their natural habitats. Adjoining this House is situated another popular House—The Sherman Hoyt Cactus House called after Mrs. Sherman Hoyt of California. This American lady presented to Kew many of the Cacti brought from California. This House has a scenic background which represents the Mohave Desert of California.

The red, blue and white Nymphæs and our Sacred lotus among the Papyrus plant of Egypt decorate the Water-lily House. The *Victoria regia* House accommodates the largest water-lily which is called after Queen Victoria. This giant water-lily of the Amazon is grown in a large rectangular tank from seeds produced in the Garden every year. By the middle of summer, this lily—one of the vegetable wonders—reaches its full growth and adult leaves at Kew measure about 7 ft. with 4-6 in. deep upturned rims. Flowers are 12 in. in diameter—at first white and fragrant but later changing to purple pink before drying up. Rice, sugarcane, cotton and a few other tropical plants are also grown in this aquatic House.

Adjacent to this House are cultivated the other vegetable wonders—the insect-eating plants. The insectivorous Sorracenias, Sundews, Venus, Flytrap, are all seen here in their full splendour. In the Nepenthes House are seen various species of Pitcher plants grown in hanging baskets with their long tender leaves, suspending at its apices pitchers of various sizes and shapes. The midribs are prolonged and dilated into pitchers, the tips of their leaves being modified into lids for covering the mouth. The insects when they slip into the pitchers are captured by the mouth of the pitcher being closed, due to the ingenious mechanism of the lid. The nutritive material produced after the decay of the insects in the digestive juice of the pitcher is absorbed by the plants which thus recoup their nitrogen deficiency.

The æsthetic side of the Kew Garden mainly consists in its maintaining what may be called —the general character of English gardening. Its spacious lawns, its long vistas, its well-plotted shrubberies and herbaceous borders, its well-proportioned mounds and dells, in proper order of sequence all add to the unique beauty of the Kew Garden. The different aspects of the Garden have their proper display too. The herbaceous grounds with their classified beds are instructive to the students of Botany. The Rose Pergola represents a section of the best varieties of climbing roses. The Berberis Dell accommodates selected species of Berberis. The Rhododendron Dell presents in May and June a glorious sight when the plants go on blooming one after the other. Their grandeur is further enhanced by bushes of Azaleas and Camelias in between also bursting out in full bloom at this time. The bamboos and grasses on one side and the taller conifers, oaks and beeches on the other side forming good background create in an Indian mind an impression of Himalayan surroundings. The Arboretum stocks a rich collection of conifers. The woodland with all tall European and American trees, neighbouring to Queen's Cottage, fulfils the forest side of the Garden. The Rock Garden, much extended and rennovated of late, is very rich in Alpine species of the different parts of the globe. Saxifragas, Primulas, Gentians, Sempervivum, Sedum, Campanulas, Veronicas, Dianthus, Silene, Aubrietias and others all flower profusely —displaying amazing delicacy in colour and grace. The advantage of diverse species in a small compass exposing *en masse* a riot of colours makes

Fig. 3.
The Alpine House in Spring with many Interesting and Rare Alpine Himalayan Species.

Fig. 4.
Group of South African Succulents.

a rock garden more and more popular in these days.

Attached to this garden is a Herbarium where are kept in classified order, in its three spacious wings, dried specimens of plants occurring in different parts of the globe (Fig. 5),—More than 4 million sheets represent the whole plant kingdom. Specimens for determination and numerous enquiries pour into the Herbarium and form the major part of the work of the Systematists. The naming of plants grown in the Garden, their distribution, economic uses, etc., are all dealt with at this sanctuary of Systematic Botany where flock in specialists from all over the world to solve their doubts with the help of the type sheets and the literature—the richest in the world, available here. Anatomical investigations are also carried on in the Jodrell Laboratory by a small band of workers.

The Head of this great British Organisation is Sir Arthur Hill, K.C.M.G., M.A., SC.D., D.SC., F.R.S., F.L.S., F.R.N.Z., V.M.H., of world-wide reputation. To him I offer my grateful thanks for giving me every possible facility to study various problems of gardening, to carry on my researches in the Herbarium, and for his permission to publish some of the photographs of the Garden.

Fig. 5.
The Herbarium, Royal Botanic Garden, Kew.

The Herbarium,
Royal Botanic Garden,
Kew, London,
August 16, 1937.

The Liquid State of Matter.

THE Sixty-fifth General Discussions of the Faraday Society centred round not any special recent discovery, but about a most common and general phenomenon, *viz.*, the nature of the liquid state. As is well known the striking aspect of this condensed state of matter is its obvious isotropic character and the consequent very suggestive close resemblance to a gas. This suggestion has indeed been so strong, and has been so much supported by the Van der Waals theory and by the initial successes of the osmotic theory of solutions, that until recently, the significance of other equally important characters of the liquid state was overlooked. For instance the molecules in the liquid state are usually just only ten per cent. less densely packed than in a crystalline solid, *i.e.*, with but a three per cent. increase in the order of intermolecular distance. One should expect from this, that the forces between the molecules must be nearly of the same order as in the crystalline state and should therefore lead to some structural arrangement with more or less permanent neighbours, while at the same time this arrangement cannot possess the regularity which characterises the crystalline

state. Indeed the modern concept of a liquid is closely related to that of crystals, and various physical and mathematical methods have been brought to bear on this problem to determine what one may call " the dynamic structure of liquids ", and correlate the same with the observed physical properties.

The group of papers presented in the symposium have been broadly divided into two sections for convenience, the first dealing with the structure and molecular forces in the pure liquids and the second with those in solutions. The subject-matter of all the papers and discussions has been cogently summarised by Dr. Butler in the compass of about three and a half pages towards the close of the book, and provides a broad survey of the whole proceedings.

In the two opening papers of the first section, one by Prof. London on the nature of the forces between atoms and molecules in liquids and the other by Dr. Bernal on a geometrical theory of the liquid state, the mathematical aspects of the liquid condition are discussed in a very lucid manner. Dr. Bernal has attempted to define the structure of a liquid in terms of a small number of variables, his formula for the distribution function containing but three, *viz.*, r the mean distance of closest approach of molecules, N the number of close neighbours of any molecule, and λ the irregularity of their distribution. With changes in temperature and pressure the equilibrium values of these variables and therefore the configuration, change, thus accounting for a greater specific heat and compressibility in the liquid state.

Among the other interesting papers in this section, attention may be drawn to the discussions by Simon and Frenkel as to how far the transition from the crystal to the liquid state should be continuous or abrupt and the attempts by Barthalome and Eucken and by Brillouin to correlate the observed specific heat of liquids with the possible molecular movements under thermal agitation. Brillouin suggests that the transverse vibrations of the solid are gradually replaced with rising temperature by rotations in the liquid, a limiting value [2 R] for the specific heat being regularly reached at the critical point. This smoothing out of finite crystal characters on passing into the liquid state leads frequently to great similarities particularly between the simple liquids in some of their physical properties. Frequently, with a suitable reduced temperature scale properties such as compressibility or functions of them for a large number of liquids fall on the same curve.

Recently, apart from X-rays, the experimental techniques of Raman spectra, infra-red spectra, and ultrasonics have also been successfully employed in throwing some light on the structure of liquids. Thus, Magat, as also Gross and Vuks observed that certain Raman lines with low frequency shifts have their origin not in the usual intra-molecular frequencies, but are caused by the inter-molecular vibrations in the liquid or crystal structures. Magat concludes from a discussion of the origin, and character of these lines, that the structural arrangement in the liquid state is more of a quasi-crystalline nature exhibiting a regularity in the mutual orientations and distances of the neighbouring molecules only, but rapidly decreasing with increasing distance. The alternative hypothesis of micro-crystalline aggregates floating in a random assembly of molecules is not supported by Raman spectra observations. In the methods of ultrasonics, opportunities are provided for the study of such characteristics as viscosity and compressibility for very quick changes of state of frequencies of the order of 10^7 per second. No decisive conclusions can however yet be drawn from these observations.

The second part of the discussions opens with an excellent introductory paper on the inter-molecular forces in solutions by Hildebrand. The problem here is even more complex, since the inter-molecular potential and structure are not easily separable factors and the differing kinds of molecules in solution offer different centres of association or clustering. This clustering may be caused by a mere difference in non-polar field strengths, by dipole association, by hydrogen bond formation, etc., consequently, the behaviour of solutions, as a whole, cannot be generalised under one head, and the objective, *viz.*, to account for and predict the deviations from an ideal mixture law for any given molecular mixture cannot be realised. It is found difficult to take completely into account the different possible variables. Thus Guggenheim has attempted by statistical methods to find what further conditions are necessary for a mixture of two species to be perfect, if it is already assumed that they mix in all proportions at constant temperature and pressure without heat effect or volume change. He finds that the mixture law is a good approximation provided the molecular volumes do not differ by more than 25%, but for greater differences in size it is not possible to predict anything. A certain amount of light is thrown upon this problem of solutions by studies of the entropy of mixing, since unequal molecular fields tend to produce aggregation and therefore a non-randomness of mixing. Scatchard, Evans, Butler, and others have contributed to this aspect of the problem. Other phenomena such as complex formation, effect of ionic forces in solutions, heats of mixing, etc., form the subjects of the other contributions to this intriguing problem of solutions.

On the whole this symposium of the Faraday Society has served in no small measure to pool together the fruits of different lines of investigation on this live problem of the molecular physics of the liquid state. A careful study of this publication will no doubt amply repay the active workers in the field with important suggestions for further work, and otherwise encourage them in their efforts. To those not specialising in this field, this book will at the same time give an admirable account of the present state of our knowledge of this problem. The book is priced at 12 *sh.* (paper cover ; 282 pp.) and is of wonderful value for the fare it offers.

M. A. GOVINDA RAU.

SCIENCE NOTES.

Himalayan Folk-lore.—Under the auspices of the Simla District Branch of the Indian Red Cross Society, H. E. Sir Herbet Emerson, delivered a lecture on "Himalayan Folk-lore" dealing with "primitive Conception in the Hills, of the Soul or Life or Breath or Spirit in Them". It was a common belief that the soul consisted of two parts the *gupt* and *chitr*, in the more Hinduised portion of Himalayas or the *hans* and *hansni* towards the borders of Tibet. Each of them could leave the body separately but if both of them left together, life will become extinct; if, on the other hand, only one left, the other will have to carry on the work of the body resulting in a wasting illness. Every man and woman was supposed to have an ordained span of life. If he or she died before this was complete, the spirit could not attain the final rest and various services have to be rendered to assist it on its way.

The belief in ghostly visitations was general and the hillman classified the ghosts according to their origin and character. Thus, there were spirits of those who met a tragic end, of those who had died with some anxiety in their minds and the spirits which lurked in waterfalls and rivers. Various customs were prevalent in different localities showing veneration to the spirits; an element of fear was also present and various precautions are taken against the release of the spirits.

* * *

Kotla Firoz Shah.—A memoir of Kotla Firoz Shah, just published by the Archæological Survey of India, describes how, in the course of a hunting expedition, Emperor Firoz Shah Tughlak noticed the famous Asokan Monolith, now standing in Kotla Firoz Shah, Delhi, and how having determined to remove it to his capital, he devised ingenious plans and carried out the operation under his supervision (Press Communique from the Director of Public Information, Government of India). The protected monument has recently been put in order by the Archæological Department, and with its spacious and well-kept grounds adds considerably to the amenities of Delhi.

* * *

The Palace of Discovery.—In a brief article appearing in *Nature* (August 1937, **21**, 328-29) Dr. Pierre Biquard has given a glimpse of the Palace of Discovery at the Paris International Exhibition, 1937, which covers an area of 23,000 sq. meters and in which are represented all branches of scientific learning, from Mathematics and Astronomy to Medicine and Botany. "Greatest efforts have been made to replace by real demonstrations the silent testimony of documents and pictures. In all sections a staff of demonstrators, escort the visitors and carry out experiments."

The development of the science of Mathematics from the earlier times and the growing importance that it has acquired in modern developments of Physics, Chemistry and Biology are exhibited in a set of rooms. In the few rooms set apart for Astronomy, are crowded all that is known about the Universe. Three models, one showing the galaxy, the second showing the sun and the twenty-five stars around it, and the last showing the sun and the planets surrounding it are exhibited. The movements of the planets is shown in the great planetorium. In the Department devoted to Physics, is a room dedicated to Galileo, where several exhibits are shown demonstrating "The foundations of the so-called rational mechanics"; then there are separate apartments devoted to Optics, Electrostatics, the subject of oscillations in which electromagnetic and sound waves are studied, Electrodynamics, and in separate sections are shown experiments on the states of matter and the structure of the atom. The Alchemist's Laboratory, Lavoisier's Laboratory, Berthelot's Laboratory and finally a Modern Chemical Laboratory comprise the Division of Chemistry where the history of the development of this branch of knowledge is shown. The Science of Biology, showing among others a living summary of the life-work of Louis Pastuer, medicine and surgery, experimental biology, plant physiology and genetics are all demonstrated. The arrangements are worthy of the many scientific men from France and abroad, who collaborated in bringing together for spectacular demonstration the numerous branches of natural knowledge. The Palace is the fruit of the labours of M. Jean Perrin, and it is to him that France owes the Palace of Discovery.

* * *

Survey of Market for Raw and Manufactured Lac Products.—The Indian Lac Cess Committee has initiated a scheme for a complete survey of market for Lac Products, with a view to assist the development of the Lac Industry in India. The Crop Statistician of the Lac Cess Committee, working under the guidance of the Agricultural Marketing Adviser to the Government of India, has been entrusted with the task of conducting the survey. With the development of synthetic products which compete with lac, it became imperative on the part of the organisation to ascertain the extent to which such lac substitutes are coming into use. While in the plastic industry the synthetics are finding favour, in the production of insulators for electric cables, and in the manufacture of paints and varnishes, shellac still holds an important position.

* * *

Mount Lucania Expedition.—Mt. Lucania, highest unclimbed peak in North America, has been scaled by Bradford Washburn, leader of the National Geographic Society—Yukon Expedition of 1935, and a companion.

In a telegram from Valdez, Alaska, to Dr. Gilbert Grosvenor, President of the Society, Mr. Washburn describes his conquest of the 17,150-foot giant of the St. Elias Range, Yukon, Canada, on July 9, and also the discovery of a large glacial valley which he named in honor of the late Dr. Frederick V. Coville, distinguished botanist and former Chairman of the Committee of Research of the National Geographic Society.

The telegram follows:

"Robert Bates and I have succeeded in climbing both Mt. Lucania, highest unclimbed peak in North America, and Mt. Steele, the two

original thwarted objectives of the National Geographic Society, Yukon Expedition of 1935. We have taken mapping photographs from the summits of both peaks and have obtained a detailed photographic record of both climbs.

"The flag of the National Geographic Society was carried throughout the course of the expedition, which also made the first crossing through the northern peaks of the St. Elias Range from Alaska into Canada over a pass 16,000 feet high.

"We have named a huge glacial valley in memory of Dr. Coville."

Mt. Steele, North-east of Mt. Lucania, rises to an altitude of 16,644 feet above sea-level. Mt. Lucania is the eighth highest mountain on the North American continent, being exceeded only by Mt. Mckinly in Alaska, Mt. Logan in Canada, Mt. St. Elias in Alaska, and four Mexican peaks.

* * *

An offer of Rs. 10,000 to perpetuate the memory of the late **Sir Ashutosh Mookherjee**, "who has done so much to further the cause of scientific research", is made to the Calcutta University by Sir P. C. Ray, for fostering research work in Zoology or Botany. Sir Profulla, who retired recently from the University services and has since been appointed Emeritus Professor of the University, placed a similar amount at the disposal of the University in 1922 for fostering research work in pure and applied Chemistry.

* * *

Dr. K. P. Jayaswal.—By the sad demise of Dr. K. P. Jayaswal, a great scholar of Indian History and Antiquities and a brilliant and energetic Research worker, India has sustained an irreparable loss. In the reconstruction of Indian History in the dark ages where continuity was lacking, Dr. Jayaswal rendered yeoman service. The *Bihar and Orissa Historic Research Society* owes its inception and development largely to him.

* * *

Indian Chemical Society.—An Ordinary Meeting of the Indian Chemical Society was held on 7th September 1937, at the University College of Science, Calcutta, Prof. J. C. Ghosh, presided.

The following gentlemen were admitted as Fellows of the Society, their subscriptions having been received for the first time.

(1) Constant Willem Pieter Van der Meydern, Imperial Institute of Sugar Technology, Cawnpore; (2) Dr. Asoke Nath Bose, B.Sc., Dr. Ing. I, Woodburn Park, Calcutta; (3) Dr. E. McKenzie Taylor, M.B.E., Ph.D., D.Sc., F.I.C., Director, Irrigation Research Institute, P.W.D., Lahore; (4) Bala Krishna Menon, Esq., M.Sc., A.I.I.Sc., University College, Rangoon, Burma; (5) Maung Po Tha, Esq., M.Sc., University College, Rangoon, Burma; (6) Yeo Sein Gwan, Esq., B.Sc., University College, Rangoon, Burma; (7) Maung San Tun, Esq., B.Sc., University College, Rangoon, Burma; (8) Champa Lal, Esq., Executive Engineer, Ludhiana; (9) K. L. Roy, Esq., M.Sc., 92, Upper Circular Road, Calcutta.

Dr. U. H. Basu read a paper on "Acridine Derivatives as Antimalarials".

Prof. J. C. Ghosh, delivered a lecutre entitled "The Directing Influence of Light in the Process of Aggregate Formation."

* * *

Protein Bread.—The search for a starch-free flour, with the valuable baking qualities of wheat has at last proved fruitful. Five Hungarian scientists after examining some 25,000 plants have at last discovered the germs of the seeds of leguminous plants, such as those belonging to certain groups of *mimosaceæ* and *Cesalpiniacea*, *i.e.*, *Cercis-genera*, contain a gluten which is identical with wheat gluten in physical properties and chemical composition (*The Science Forum*, 1937, **2**, 107). The flour contains 61·5 per cent. protein, and is quite free from assimilable carbohydrates. Because of its obvious importance as a food in cases of diabetes, obesity, catarrh and many other ailments, the flour is highly valued by the medical profession. A very important property of this new flour is, its acid-binding value, 1 gram of this flour being capable of neutralising 45 c.c. of N/10 hydrochloric acid. The importance of this will be realised at once, when it is mentioned that it can be used to neutralise excess acid in cases where acute discomfort is caused by excessive acid secretion by the starch due to the breakdown of regulating mechanism. Even when taken in large quantities, the flour does not cause glycosuria or hyperglycæmia. It is not fattening; on the other hand, it is "fat reducing". Remarkable results have been recorded in clinics and hospitals, where the new flour has been introduced with the dietary of diabetics.

* * *

University of Mysore.—

1. *Personnel.*—Mr. K. S. K. Iyengar, B.A. (Hons.) (Cantab.), Professor of Mathematics, Central College, Bangalore, has been granted combined leave for 4 months and 13 days from the 12th August 1937.

2. *Examinations.*—The results of the M.A. and M.Sc. degree examinations were published during the month. They were as follows:—

Name of Examination	Examined	Passed I Class	Passed II Class
M.A.	11	2	9
M.Sc.	12	5	6

3. *Convocation.*—The 20th Annual Convocation for conferring degrees will be held in Mysore on the 29th October 1937, at 9 A.M.

4. *Academic Council.*—A meeting of the Academic Council was held on the 27th August 1937. Among the decisions arrived at, mention may be made of the following:—

(i) Prescribing the minimum percentage of marks to be obtained by candidates for the S.S.L.C. Examination under the revised scheme, for being eligible for admission to University Courses of study. (ii) Courses of Studies and Scheme of examination in Hindi as an optional subject for the Intermediate Examination in Arts. (iii) Addition of the following to the list of optional groups enumerated in Ordinance 71 for the B.Sc. degree Examination: (*a*) Physics, Mathematics and Economics; (*b*) Chemistry

Geology, Botany; (c) Chemistry, Geology, Zoology. (iv) Provisions for candidates for the B.A. degree under the old rules, who have not been able to complete the degree under the transitory rules. (v) Provision for candidates for the Honours degree failing to qualify for the degree.

At the above meeting, the Vice-Chancellor's note on Post-Secondary Vocational Courses was considered and the matter was referred to a Committee for formulating proposals.

5. *Endowments.*—The terms of award of the following endowments were accepted by the Council:—

(*a*) "The Siraj-ul-Ulema Syed Shahboodin Sajjada Scholarship," founded by Moin-ul-Vizarath Mr. A. K. Syed Taj Peeran Sajjada, Retired Deputy Commissioner: Rs. 5,000. (*b*) "The S. R. Seethamma Prize," by an anonymous donor: Rs. 1,500. (*c*) "The Paráki Medical Scholarship" founded by Mr. P. S. Govinda Rao, Retired Deputy Conservator of Forests.

6. *University Extension Lectures.*—The programme of extension lectures for 1937-38 has been drawn up. A list of lectures which are definitely accepted will be published as soon as practicable.

7. *Kannada Publications.*—*Hanaprapancha* and *Sanskrit Drama*, Kannada publications of the University, were issued during this month.

* * *

Royal Institute of Science.—The University Inspection Committee consisting of Messrs. S. G. Burrow, G. Palacios, N. M. Shah and D. D. Karve visited the Institute on the 27th August.

Dr. F. R. Bharucha has been appointed a member of the Editorial Committee of the Imperial Council of Agricultural Research.

Dr. H. J. Bhabha, a distinguished past student of this Institute has been awarded the 1851 Exhibition Scholarship at Cambridge.

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We acknowledge with thanks, receipt of the following:—

"Journal of Agricultural Research," Vol. 54, No. 12; Vol. 55, No. 1.

"Monthly Bulletin of Agricultural Science and Practice," Vol. 28, No. 8.

"The Philippine Agriculturist," Vol. 26, No. 3.

"Journal of the Royal Society of Arts," Nos. 4418-4422.

"Biochemical Journal," Vol. 31, Nos. 6-7.

"Chemical Age," Vol. 37, Nos. 943-947.

"Journal of the Indian Chemical Society," Vol. 14, No. 6.

"Journal of Chemical Physics," Vol. 5, No. 8.

"Experiment Station Record," Index to Vol. 75.

"Transactions of the Faraday Society," Vol. 33, No. 196.

"Indian Forester," Vol. 63, No. 9.

"Forschungen und Fortschritte," Vol. 13, Nos. 20-24.

"Medico Surgical Suggestions," Vol. 6, No. 8.

"Calcutta Medical Journal," Vol. 32, No. 8.

"Review of Applied Mycology," Vol. 16, Part 8.

"Nature," Vol. 140, Nos. 3534-3538.

"Journal of Nutrition," Vol. 14, No. 2.

"Canadian Journal of Research," Vol. 15, No. 7.

"Ceylon Journal of Science," Vol. 20, Part 3.

"Science and Culture," Vol. 3, Nos. 2 and 3.

"Sky," Vol. 1, No. 10.

"Lingnan Science Journal," Vol. 16, No. 3.

"Indian Trade Journal" Vol. 126, Nos. 1625-1628.

ACADEMIES AND SOCIETIES.

The Indian Academy of Sciences:

August 1937. SECTION A.—B. V. THOSAR AND B. K. SINGH: *The Raman spectra of* dextro, lævo, *and Racemic forms of Borneol and Camphor.*—The substances have been studied in the crystalline state. The spectra for the different optical isomers are identical. S. RANGASWAMI AND T. R. SESHADRI: *Constitution of Coumarino-pyrones derived from 7-hydroxy-Coumarins.*—It is concluded that the angular isomer is the predominant derivative, although the linear variety is not altogether precluded. N. G. SHABDE: *On the Series of Jacobi-polynomials and definite Integrals involving Bessel Functions.* W. M. VAIDYA: *The Flame Spectra of some Aliphatic halides.—Part I. Methyl Iodide.*—A number of new bands have been observed which may be due to IO. B. S. MADHAVA RAO: *Ring-Singularity in Born's Unitary Theory—II.* R. D. DESAI AND M. A. WALI: *Studies in the Friedel-Crafts Reaction—Part II. The Condensation of the anhydrides of as-disubstituted succinic acids with benzene and toluene. Part III.—The Condensation of succinic anhydride with the methyl ethers of the Phenol and the Cresols.*—The condensations give rise to isomeric keto-acids whose constitution and origin are investigated. P. SURYAPRAKASA RAO, C. VENKATA RAO AND T. R. SESHADRI: *Geometrical Inversion in the acids derived from the Coumarins.—Part V. The Behaviour of Psoralic and Isopsoralic Acids.*—These stable trans-acids undergo with concentrated sulphuric acid complex changes whereas in the presence of sunlight and aqueous mercuric chloride they yield the original pyrones.

August 1937. SECTION B.—KURIEN JACOB: *On Protocyathea rajmahalense* sp. nov., *A Cyatheaceous Tree-fern, with Notes on the Geological*

Distribution of the Cyatheaceæ.—The specimens described were collected from certain plant-bearing beds at Sakrigalighat, in Bihar. Although a definite opinion on the Geological age of the beds cannot be ventured at this stage it is mentioned that *Protocyathea* is a genus previously recorded only from the cretaceous rocks. A. L. SUNDAR RAO: *Studies in the Physical and Chemical Properties of some Sugarcane Soils.*—The colloid content, chemical composition and spectroscopic examination of the minor constituents. There appears to be no significant difference in soil composition. I. FROILANO DE MELLO AND CAETANO CORREA DE MEYRELLES: *On the Nature and Identification of Some Roundish Bodies found either Free or as Endoglobular Parasites in the Blood of* Calotes versicolour *Daud. Subspecies* Major *Blyth.*—Among numerous specimens of *Calotes versicolor* Subspecies *major*, one of them showed minute roundish curious parasites which have been described. B. P. PANDE: *On some digenetic Trematodes from* Rana cyanophlyctis *of Kumaon Hills.*—The common frog found in the streams near Almorah and in the lake at Bhimtal, is usually infected with the trematodes belonging to the genera *Diplodiscus* Diesing, 1836, *Pneumonœces* Looss, 1902 and *Ganeo* Klein, 1905, which are described in this paper. JAGJIWAN SINGH: *Studies in Soil Bacteria of the Subtropical Region-Punjab, North India.*—The variation in bacterial number, due to season, temperature, moisture and rainfall has been studied.

The National Academy of Sciences:

August 13, 1937.—R. L. GUPTA: *On the Salivary glands in the order Coleoptera—Part I. The Salivary glands in the Family Tenebrionidæ.* R. D. VIDYARTHI: *New Strigeids (Trematode) from Indian Birds.* SHAH MUHAMAD SULAIMAN: *The Mathematical Theory of a New Relativity, Chapter XV. The Rotational Theory of Light and Matter.* BINAYENDRA NATH SEN: *On Parachor and Thermal Conductivities of Metallic Elements.* MUHAMMAD MUQTADIR: *The Inverse Square Law, a Demonstration.* J. H. MITTER AND R. N. TANDON: *Fungi of Mussoorie—Part I.*

Indian Chemical Society:

July 1937.—SHRIDHAR SARVOTTAM JOSHI AND DUSHYANT NARASINGASA SOLANKI: *The Influence of Strong Electrolytes and Mercuric Chloride on the Conductivity of Aqueous Benzoic Acid.* HARISH CHANDRA BHATNAGAR, NARENDRA NATH CHOPRA, KARTAR SINGH NARANG AND JNANENDRA NATH RAY: *Some Bases of Physiological Interest.* HIRENDRA NATH DAS-GUPTA: *Studies in Organo-arsenic Compounds. Part V.—Synthesis of Arsindole Derivatives.* NIRMALANANDA PALIT: *A Modification of the Guareschi Pyridine synthesis—Part II.* HIRENDRA NATH DAS-GUPTA: *Simultaneous Determinations of Chlorine, Nitrogen and Arsenic in Organo-arsenic Compounds.* G. P. PENDSE AND JAGRAJ BEHARI LAL: *Constitution of the Seeds of* Blepharis edulis, *Pers. Part II.—The Composition of the Oil.* G. P. PENDSE: *Chemical Examination of the Fruits of* Solanum nigrum, *Linn. Part I. The Composition of the Oil from the Seeds.* C. R. N. REDDY AND B. S. SRIKANTAN: *Weighting of Indian Silk.* BALWANT SINGH AND IJAZ ILAHI: *Potentiometric Studies in Oxidation-reduction Reactions. Part II.—Oxidation with potassium Iodate*; B. C. KAR: *Oxidative Deamination of Amino-acids.* SHRIDHAR SARVOTTAM JOSHI AND P. V. JAGANNATHA RAO: *Studies in the Coagulation of Colloids. Part XVIII. The Zonal Effect and Antinormal Change of Opacity during the Slow Coagulation of Colloidal Manganese Dioxide.*

Meteorological Office Colloquium, Poona:

Dewan Bahadur SIR T. VIJAYARAGHAVACHARYA addressed a meeting of the Colloquium on the 29th July 1937. He referred to the importance of scientific research in general and to the rôle that meteorologists in India could play in the service of agriculture in particular.

Three meetings were held in August 1937, the programme being as follows:—

10-8-37 MR. L. S. MAHALINGAM—"An Analysis of Indian Rainfalls using the Median as a Statistic".

17-8-37 MR. K. P. RAMAKRISHNAN—"Dr. Borchardt's article on 'Medical Climatology-Climatopathology".

24-8-37 DR. N. K. SUR—"Soundings of the Atmosphere over Jhikargacha (Bengal) in April & May 1929".

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